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MATERIALS SCIENCE AND METALLURGY

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MATERIALS SCIENCE AND METALLURGY

No. 81

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RECRYSTALLIZATION OF Al-Sc ALLOYS

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 1, Jan-Feb 82
(manuscript received 22 Dec 80) pp 173-178

DRITS, M. Ye., TOROPOVA, L. S., BYKOV, Yu. G., BER, L. B. and PAVLENKO, S.G.,
Moscow

[Abstract] A study is made of the influence of alloying with scandium on the temperature interval of recrystallization of aluminum. The studies were based on type A99 pure aluminum alloyed with up to 0.75% Sc in a laboratory induction furnace in an atmosphere of argon. Flat blanks in the annealed, hardened and aged states were rolled in cold water with 50% deformation. Isochronic annealing (1 hour) of the cold rolled sheets and hot pressed bars was performed to determine the temperature of the beginning and ending of recrystallization by metallographic studies in polarized light and x-ray studies. Hardness and resistivity were measured and the lattice period was determined. Electron microscope examinations were conducted to determine the mean particle diameter. Anomalous supersaturated solutions with higher scandium concentration than the maximum solubility were found. The temperature interval of recrystallization depends on the particle size of the ScAl_3 particles in the initial deformed state and on the change in particle size during the process of recrystallization heating. Particles measuring less than 100 Å in diameter with an interparticle distance of less than 1000 Å increase the temperature of beginning by 125-175°C, the temperature of ending by 125-250°C depending on the scandium content. The high stability of the unrecrystallized structure of Al-Sc alloys results from the formation of small spherical uniformly distributed coherent ScAl_3 particles, resulting from decomposition of the solid solution. Figures 4; references 9: 8 Russian, 1 Western.
[86-6508]

INFLUENCE OF PRELIMINARY PLASTIC DEFORMATION ON FATIGUE PROPERTIES OF
ALUMINUM ALLOYS

Kiev PROBLEMY PROCHNOSTI in Russian No 2, Feb 82
(manuscript received 25 Jun 79) pp 70-73

GETMAN, A. F. and SHTOVBA, Yu. K., "Energiya" Scientific-Production
Association

[Abstract] A study was made of alloys deformed to various degrees of plastic deformation by compression or extension immediately after hardening. After deformation the billets were artificially aged, then specimens were cut from them. Fatigue testing was performed on standard cylindrical specimens under cantilever circular flexure conditions except for V93 alloy for which pressed strips were used and AK⁴ alloy, which was tested in pure circular flexure. The influence of plastic deformation on the equation describing the fatigue curves of the metal studied was also analyzed. Comparison of experimental and calculated data using the equation presented indicates satisfactory agreement. Figures 2; references 6: all Russian.
[95-6508]

BERYLLIUM

UDC: 669.725:539.219.3

DIFFUSION OF NONMETALLIC ELEMENTS IN BERYLLIUM

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 52, No 6, Dec 81
(manuscript received 19 Dec 79, in final form 9 Dec 80) pp 1318-1320

ANAN'IN, V. M., GLADKOV, V. P., ZOTOV, V. S., SVETLOV, A. V. and
SHABALIN, A. N.

[Abstract] A method of multilayer radiometric analysis is used to study the diffusion mobility of ^{75}Se , ^{35}S and ^{32}P in polycrystalline beryllium with residual resistivity equal to 30. Ingots were obtained by remelting beryllium distillate in an electric arc furnace, then were subjected to high temperature homogenization annealing, then cut on an electric spark machine into plane parallel specimens measuring 10 x 10 x 5 mm. The radioactive isotopes were applied to the polished surface: selenium by atomization in a vacuum installation, sulfur as a benzene solution with subsequent evaporation and phosphorus as orthophosphoric acid in a benzene solution. The depth of penetration at the maximum temperatures was 50 μm in 5 hours for selenium, 60 μm in 40 hours for sulfur and 1200 μm in 2 hours for phosphorus. It is assumed that the diffusion of the nonmetallic elements into the beryllium occurs by a different mechanism than the diffusion of metallic elements. Figures 2; references 7: 5 Russian, 2 Western.
[82-6508]

UDC: 620.197.6

ELECTROCHEMICAL STUDIES OF PROTECTIVE PROPERTIES OF METALLIZED COATINGS IN MINERALIZED WATER

Tbilisi SOOBSHCHENIYA AKADEMII NAUK GRUZINSKOY SSR in Russian Vol 103, No 3, Sep 81 (manuscript received 31 Jul 81) pp 629-632

AGLADZE, R. I., academician, Georgian Academy of Sciences, EKIZASHVILI, G. Sh., KRAMARENKO, D. M., ANDRYUSHENKO, Ye. A. and SAVITSKAYA, N. I.

[Abstract] A study was made of the protective properties of metallized coatings of Zn and Al under conditions as close as possible to the underground conditions of the Tbilisi subway system. Systematic studies of the corrosion status of metal structures performed over a period of more than 10 years in eight sections of the subway with simultaneous determination of the composition of the atmosphere and groundwater have shown that the following factors result in significant corrosion: exposure to warm sulfur-containing mineral water (8-78.2 mg/l hydrogen sulfide, total quantity of sulfates, bicarbonates and chlorides 15-30 g/l); corrosive atmospheres containing many components including H₂S, high relative humidity, temperature 6-26°C. Coatings of aluminum and zinc were applied to plates of hot rolled type ST3 steel which had been shot peened. Corrosion was reduced by Al coatings over 200 µm thick and Zn coatings over 50 µm thick. The aluminum coatings are preferable to zinc because the corrosion current which arises in the steel-aluminum coating system is an order of magnitude lower than that in the zinc-steel system. Figures 3; references 3: all Russian.

[90-6508]

COMPOSITION AND STRUCTURE OF MULTICOMPONENT COATING ON ST3 STEEL AND ITS CORROSION RESISTANCE IN MOLTEN SULFUR

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 1, Jan 82 pp 19-20

IGNATENKO, P. I., PRODAN, N. Ye. and IVANITSYN, N. P., Donetsk State University

[Abstract] Specimens of St3 steel were impregnated with a 70% Al + 10% NaF (activator) + 20% Cr (or Ni or Cr+Ni) paste, for the purpose of forming a corrosion resistant coating. A 5% solution of BF-6 adhesive in acetone was used as binder. The structure of surface layers was examined by x-ray diffraction with Cr K_α - radiation, by metallographic analysis under a microscope and microhardness tests with a 1 N load. Corrosion tests were performed in molten sulfur at 130°C, by weighing every 8-10 h over a 90 h period. The coating formed by aluminum-chromium paste was found to consist of a continuous thin $\text{FeO}(\text{Cr}_2\text{O}_3, \text{Al}_2\text{O}_3)$ layer with a coarse-grain oriented α -phase $\text{Al}_{13}\text{Cr}_6\text{Si}_4$ layer and a cubic Fe_3Al layer underneath. The coating formed by aluminum-nickel paste was found to consist of an Fe_5Si_3 layer with a coarse-grain Ni_3Al layer and a cubic Fe_3Al layer underneath. The coating formed by aluminum-nickel-chromium paste was found to consist of an $\text{FeO}(\text{Cr}_2\text{O}_3, \text{Al}_2\text{O}_3)$ layer with a coarse-grain oriented $\text{Al}_{13}\text{Cr}_6\text{Si}_4$ layer and a very thin Fe_3Al layer underneath. The corrosion of St3 steel without coating at a rate of $11.584 \cdot 10^{-5} \text{ kg}/(\text{m}^2 \cdot \text{h})$ was slowed down to $3.345 \cdot 10^{-5} \text{ kg}/(\text{m}^2 \cdot \text{h})$ by an Al-Cr coating, to $1.02 \cdot 10^{-5} \text{ kg}/(\text{m}^2 \cdot \text{h})$ by an Al-Ni coating and to $0.901 \cdot 10^{-5} \text{ kg}/(\text{m}^2 \cdot \text{h})$ by an Al-Ni-Cr coating. On the basis of these results, Al-Ni and Al-Ni-Cr pastes can be recommended as coating for railroad tankers carrying molten sulfur or other liquids containing sulfur. Figures 1; references 7: 6 Russian, 1 Western.

[72-2415]

SUCCESSIVE IMPREGNATION OF CARBON STEELS WITH ALUMINUM AND BORON

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian
No 1, Jan 82 pp 16-19

KAYDASH, N. G., CHASTOKOLENKO, P. P. and CHASTOKOLENKO, L. N.,
Kiev Polytechnic Institute, Cherkassy branch

[Abstract] Specimens of carbon steels 45 and U8 were impregnated first with aluminum and then with boron by successive diffusion at 950-1100°C. The coating thus formed was found to consist of an outer boride layer containing FeB and Fe₂B, and an inner aluminide layer containing Fe₃Al. A boride interlayer was found between the coating and the base metal, its thickness and continuity depending on the thickness of the Fe₃Al phase in the aluminide layer and on the boronizing process parameters. The thickness of the aluminide-boronide coating appears to depend parabolically on the impregnation time and exponentially on the impregnation temperature. Boronization of the aluminide layer results in passivation of the latter, as long as the latter does not contain more aluminum than is contained in the Fe₃Al phase. The boronization process is most effective at 1000°C or higher impregnation temperatures. Alloys which FeB and Fe₂B form with aluminum lower the microhardness and increase the plasticity of the coating. Figures 4; references 2: both Russian.

[72-2415]

COMPOSITE MATERIALS

UDC: 624.074.678.067

THERMOELASTIC STRESSES AT FREE EDGE OF CYLINDRICAL SHELLS OF CROSS-REINFORCED COMPOSITE

Riga MEKhanika Kompozitnykh Materialov in Russian No 6, Nov-Dec 81
(manuscript received 8 Apr 81) pp 1030-1034

ANTOKHONOV, V. B., Moscow Institute of Engineering

[Abstract] During heat treatment and other temperature effects on shells of cross reinforced composites the development of significant stresses between layers is observed. In this work the rigid layers containing reinforcing elements are looked upon as Kirchhoff-Love shells, while tensile deformations in the direction of perpendiculars and transverse shear deformations are considered in the soft layers of binder between the reinforcement layers. A thin circular cylindrical shell of this type is studied. Equations are generated and numerically solved by a computer. The solution of the boundary-value problem is sought by simple superimposition of the two solutions, assuming that the characteristic scale of the interlayer edge effect for the shell has the same order of magnitude as for a plate. Curves illustrate the change in stresses near the edge for two and four layers. Figures 2; references 11: 8 Russian, 3 Western.
[67-6508]

UDC: 661.862.001.5

SINTERING AND CERTAIN PROPERTIES OF COMPOSITES IN $Al_2O_3-Al_2TiO_5$ SYSTEM

Moscow OGNEUPORY in Russian No 12, Dec 81 pp 40-44

KOLOMEYTSSEV, V. V., Podol'sk Refractory Products Plant, and SUVOROV, S. A., MAKAROV, V. N. and BULATOV, S. V., Leningrad Institute of Technology imeni Lensev

[Abstract] Refractory materials must be able to withstand thermal shock. The system $Al_2O_3-Al_2TiO_5$ is promising in this respect. A study was made of

sintering of composites, of their mechanical, thermophysical properties and their interaction with the microstructure and thermal stability. Specimens were made of semidry masses and roasted in a flame furnace at 1680°C. The dispersion of the initial components was such that compact materials are produced at 1600-1700°C, and preliminary experiments establish that the fragmentary structure was formed stably in the 1600-1700°C temperature interval. Photomicrographs of the microstructure of composite specimens are presented. The thermal stability was studied by the method of radial heat flux and the residual tensile strength after a series of thermal shocks was determined. The best properties were found in composites containing 30 to 50% Al_2TiO_5 . An anomalous increase in high temperature strength in the 20 to 1200°C temperature interval was found for composites of this composition, resulting from separation of products of the decomposition of Al_2TiO_5 along the crystalline boundaries of the refractory base and the development of an elastic-stress state. Figures 7; references 10: all Russian.
[75-6508]

UDC: 539.4:678.067

DISTRIBUTION OF STRESS IN COMPOSITE MATERIAL WITH LOCAL LOSS OF PLASTIC STABILITY OF FIBERS

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 6, Nov-Dec 81
(manuscript received 22 Sep 80) pp 1012-1017

OVCHINSKIY, A. S. and CHERVENKOVA, I. A., Institute of Metallurgy imeni A. A. Baykov, USSR Academy of Sciences, Moscow

[Abstract] The fracture of composite materials is often preceded by a stage of accumulation of damage which can be described by statistical methods. A necessary component part of modeling of the processes of fracture is a study of the redistribution of stresses in the composite material as necks develop in a fiber. The precise solution of the distribution of stresses in a three dimensional statement is difficult and apparently unnecessary. In this work this task is performed within the framework of a one dimensional model, i.e., the redistribution of stresses along a single axial coordinate is studied. A volume of material is studied containing a fiber in which a neck has developed. The neck usually appears with significant plastic deformation of the fiber. Thus the actual stress-strain of the fiber can be approximated by a rigid-plastic diagram with linear hardening. The analysis performed allows the construction of a mathematical model of the fracture of a composite material, i.e., relation of the statistical accumulation of damage in the form of local events of loss of plastic stability of fibers with subsequent rupture to fracture or loss of plastic stability in the composite as a whole. Figures 2; references 5: all Russian.
[67-6508]

BEHAVIOR OF POLYMERS AND COMPOSITES IN COMBINATION OF DEFORMATION CREEP
AND FRACTURE

Riga MEKHANIKA KOMPOZITNYKH MATERIALOV in Russian No 6, Nov-Dec 81
(manuscript received 7 Feb 80) pp 970-975

RATNER, S. B. "Plastmassy" Scientific-Production Association, Moscow

[Abstract] With fracture and creep combined the question arises as to which is the primary process. The answer to this question is found in the thermal fluctuation representation of the mechanization of fracture and deformation, indicating that both processes occur by the breaking of various bonds by thermal fluctuations. A graph of the influence of temperature on the durability of polymethylmethacrylate is used as an example to illustrate the presence of two bundles of lines, indicating that the brittle fracture and creep resistance of polymers is determined by two groups of similar but numerically different physical constants of the material. The boundary between the two bundles of lines is a straight line passing through both poles. The slope of this line corresponds to the effective activation energy of the process at the boundary stress above which brittle fracture occurs, below which critical deformation occurs. Under constant load, either process may predominate. Since the boundary between the areas is determined by the stress, regardless of temperature and time of application, a change in stress leads to transition from one area to the other and therefore to a change in the nature of the most important process. Figures 2; references 14:
all Russian.
[67-6508]

CORROSION

UDC: 669.14.018.8:[621.787+620.193/194]

CORROSION RESISTANCE OF 12Kh18N10T STEEL AFTER HIGH TEMPERATURE THERMOMECHANICAL WORKING

Kiev FIZIKO-KHIMICHESKAYA MEKhanika MATERIALOV in Russian Vol 17, No 6, Nov-Dec 81 (manuscript received 16 Apr 80) pp 20-25

YAKOVLEV, V. B., VASIL'YEV, V. Yu., BERNSHTEYN, M. L., ISAYEV, N. I. and KAPUTKINA, L. M., Moscow Institute of Steels and Alloys

[Abstract] Austenitic stainless steel type 12Kh18N10T was studied after high temperature thermomechanical working, with conditions selected to achieve various distributions of dislocations without significantly changing grain size or the status of the carbide phase. Electrochemical studies were performed in a P-5827m potentiostat. The high temperature thermomechanical working increased the yield point by 30 to 70%, without significantly changing the ultimate strength. Plasticity decreased slightly, though remaining at a rather high level. The greater the degree of deformation during high temperature thermomechanical working, the more the steel was hardened; increasing deformation temperature accelerates processes of dynamic softening. The optimal conditions are recommended: 1273°K, $\epsilon = 42$, $\dot{\epsilon} = 0.76$. Figures 3; references 12: 9 Russian, 3 Western. [66-6508]

UDC: 620.197.2:620.173.3

CORROSION RESISTANCE OF ALUMINUM ALLOYS ANODIZED IN SOLUTIONS OF SULFURIC ACID AND ORGANIC SUBSTANCES

Kiev FIZIKO-KHIMICHESKAYA MEKhanika MATERIALOV in Russian Vol 17, No 6, Nov-Dec 81 (manuscript received 29 Jul 80) pp 105-106

KARLASHOV, A. V., GAYNUTDINOV, R. G. and GOLUBNICHIIY, A. V., Kiev Institute of Civil Aviation Engineers

[Abstract] In order to expand knowledge concerning the mechanism of anodic films on fatigue and corrosion-fatigue strength of aluminum alloys,

experiments were performed on V95 alloy. Specimens anodized in a sulfate electrolyte and compressed in an aqueous solution of potassium bichromate and thiocarbamide were subjected to corrosion fatigue testing at 160 MPa in 3% sodium chloride, dripped onto the experimental surface. Another batch of specimens anodized by the same method was compressed in a solution of potassium bichromate without thiocarbamide, but was tested with thiocarbamide added to the 3% sodium chloride solution dripped onto the specimens. The corrosion resistance depends significantly on the nature of the substances used in the anodizing electrolyte. The maximum shielding effect was achieved by the anode film formed in the sulfate electrolyte with 10 g/l thiocarbamide, the minimum shielding effect--in the electrolyte with 1.0 g/l benzonitrile.

References 2: both Russian.

[66-6508]

HEAT TREATMENT

UDC 621.78.061

NEW ELECTRIC VACUUM FURNACE WITH FAST-COOLING CHAMBER

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 1,
Jan 82 pp 35-36

GURVICH, O. S. and MAKARENKO, S. V.

[Abstract] A new small compartmental electric vacuum furnace has been developed and will be produced for heat treatment with fast cooling, at rates much higher than possible in furnaces now produced in the Soviet Union. This CNVE-1.3.1/16I2 device comprises two adjacent horizontal cylindrical chambers with equal diameters, one for heating and one for water cooling. There are two fixed stacks of shields in the heating chamber and two stacks of shields movable into the cooling chamber, each stack consisting of four molybdenum and two 12Kh18N10T steel shields. Vacuum is maintained by means of a main diffusion pump for the heating chamber and a booster diffusion pump for the cooling chamber. The electric heater is supplied through a transformer and a thyristor bank. Temperature is measured and regulated by means of a tungsten-rhenium thermocouple. Interlocking is provided for fault prevention. Heat treated Permalloy cores weighing 6 kg each and compactly filling the furnace space can be cooled from 1200 to 200°C at a rate of 37°C/h in vacuum of 6.65 mPa or at 706°C/h in an argon atmosphere. Other magnetically soft materials can also be cooled at rates much higher than according to Government Standard 10160-75. Figures 2.
[72-2415]

STRUCTURAL CHARACTERISTICS OF HYPEREUTECTOID TOOL STEELS AFTER
LASER-HEAT TREATMENT

Moscow IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: CHERNAYA METALLURGIYA
in Russian No 12, Dec 81 (manuscript received 4 Mar 81) pp 56-58

VORONOV, I. N., VELIKIKH, V. S. and GONCHARENKO, V. P., Belgorod
Technological Institute of Structural Materials

[Abstract] The microhardness of three tool steels was measured before and after case hardening by heat treatment with a "Kvant-16" neodymium-glass laser ($\lambda = 1.06 \mu\text{m}$). The case on U8 steel was found to be uniform over the "hot spot", the microhardness having increased from 6470 to 9600 N/mm² over the entire area and throughout the case depth. The case on hypereutectoid KhVG and U12 steels (microhardness before heat treatment 6860 and 6760 N/mm² respectively) was found to be nonuniform, the microhardness reaching its maximum not at the surface (8340 and 8140 N/mm² respectively) but 9220 and 9020 N/mm² respectively at a 40-50 μm depth below. Metallographic and x-ray diffraction analysis has revealed a partial dissolution of carbides and alloying of residual austenite at temperatures up to 1670°K attainable within the "hot spot" of laser action. The concentration of residual austenite in the case layer, still 50-60% at the top, decreases further depthwise and this causes the microhardness to increase in the same direction. Figures 3; references 2: both Russian.

[70-2415]

MAGNESIUM

UDC: 620.17.172/178.2

BAUSHINGER EFFECT IN ML8 MAGNESIUM ALLOY

Kiev PROBLEMY PROCHNOSTI in Russian No 1, Jan 82
(manuscript received 5 Mar 81) pp 83-85

FEDORIN, A. M., KHIL'CHEVSKIY, V. V. and STRIZHALO, V. A., Kiev
Polytechnical Institute; Institute of Strength Problems, Ukrainian Academy
of Sciences

[Abstract] The Baushinger effect, formulated in terms of stress, is manifested in that a material experiencing axial force in one direction in the area of plastic deformation has reduced resistance to plastic deformation when force is applied in the other direction. This effect is particularly important for magnesium alloys. Manifestations of the effect were studied for new high strength casting alloys such as ML8. The chemical composition consists of Mg plus 5.54% Zn, 0.5% Cd and 0.87% Zr. Heat treatment included hardening from 485°C, cooling in air, and subsequent aging for 24 hours at 165°C. It was found that repeated loading in the opposite direction (tension after preliminary compression or compression after preliminary extension) of ML8 high strength casting alloy produced a change in proportionality limit and yield point upon reapplication of opposite direction loading significantly less than in MA2 and MA5 alloys. Figures 3.

[81-6508]

FORMATION AND GROWTH OF FATIGUE CRACKS IN MAGNESIUM ALLOYS WITH VARIOUS STRUCTURES

Kiev PROBLEMY PROCHNOSTI in Russian No 1, Jan 82
(manuscript received 3 Oct 80) pp 61-67

GRINBERG, N. M., SERDYUK, V. A., MALINKINA, T. I. and KAMYSHKOV, A. S.,
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Ukrainian Academy of Sciences, Khar'kov

[Abstract] A study is presented of the duration of the period of fatigue cracks and their growth rate in certain magnesium alloys with varying microstructure, as well as determination of the threshold and critical points of crack growth. The growth rate of penetrating cracks was studied over the entire range of change of the coefficient of stress intensity, as well as that of small nonpenetrating cracks, since it has been found that the growth rates are different for these two different types of cracks under identical stress intensity conditions. Trapezoidal specimens with semicircular lateral notches were made of 6 different heat treated magnesium alloy sheets, and then the flat surfaces were mechanically and electrolytically polished. Deformation was by cyclical symmetrical cantilever bending at 12.5 Hz. It is found that the purity of the alloy and heat treatment as well as the alloying and structural state determine the length of time required for crack formation and the rate of subsequent crack growth in magnesium alloys. The best characteristics are those of MA2-1, the worst--MA12 (T2) alloys. The micromechanisms of fatigue crack growth in magnesium alloys depend on the structural state. The cyclical toughness of magnesium alloys can be determined from the fatigue crack growth rate diagram and the size of the zone of fatigue fractures of smooth specimens. The threshold and critical stress intensity factors depend on the yield point, increasing with it to a certain limit, then decreasing. Figures 5; references 18: 14 Russian, 4 Western.
[81-6508]

MECHANICAL PROPERTIES

UDC: 539.4.015:669.018.44

INFLUENCE OF PRELIMINARY TEMPERATURE AND FORCE EFFECTS ON MECHANICAL PROPERTIES OF EI698VD HEAT RESISTANT ALLOY

Kiev PROBLEMY PROCHNOSTI in Russian No 2, Feb 82
(manuscript received 2 Feb 81) pp 66-70

KODNER, M. Ya., ZHELDUBOVSKIY, A. V., PALIYENKO, Ye. Ya. and POGREBNYAK, A.D.,
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[Abstract] In order to determine the operating life of EI698VD alloy, a study was made of the influence of high temperatures as well as preliminary exposure to high temperatures and mechanical stress, on the mechanical properties of the alloy. Material used was freshly alloyed specimens of the nickel alloy used for gas turbine wheels. Short term static strength testing of specimens heat treated by the standard conditions in the temperature range from 293 to 673-773°K indicated that the temperature variation of ultimate strength, reduction in area and relative elongation decreases monotonically. The studies indicate that the alloy retains its properties and effectiveness during long term operation in the operating temperature range, the strength properties increasing or stabilizing due to hardening in use. Only at the top of the temperature range is a tendency observed toward decreasing short term and long term strength characteristics resulting from coagulation of the hardening phase. Figures 4.
[95-6508]

EFFECT OF SMALL AMOUNTS OF ADDITIVES ON MECHANICAL PROPERTIES AND
STRUCTURE OF HIGH-STRENGTH CAST ALUMINUM-COPPER ALLOYS

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA
in Russian No 6, Nov-Dec 81 (manuscript received 4 Feb 81) pp 61-66

BAKIROV, Zh. T., POSTNIKOV, N. S., ISTOMIN-KASTROVSKIY, V. V. and
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Science, Moscow Institute of Steel and Alloys

[Abstract] The general trend toward the use of additional alloying elements for production of high-strength materials applies also to cast aluminum alloys. An experimental study was made to collect data on the effects of cadmium (0.19-0.24%), manganese (0.67-0.77%), titanium (0.15-0.45%), and zirconium (0.13-0.20%) on the mechanical properties and the structure of the cast Al + 5 wt.% Cu alloy after quenching and subsequent natural aging (30 days at 20°C) or artificial aging (4-100 h at 170°C). The elements were added alone, in combinations of two, in combinations of three, and all four. Specimens of the alloys thus produced were tested mechanically for tensile strength and yield strength, and their structure was examined by x-ray diffraction under an electron microscope. Figures 2; references 9: 5 Russian, 4 Western.

[69-2415]

UDC: 536.2.537.312.6+621.762.8

INFLUENCE OF DIFFUSION OF COMPONENTS WITH LIMITED MUTUAL SOLUBILITY ON
CONDUCTIVITY OF POWDER COMPOSITES

Kiev POROSHKOVAYA METALLURGIYA in Russian No 2, Feb 82
(manuscript received 2 Apr 81) pp 71-76

ZARICHNYAK, Yu. P. and NIKOSHINA, Ye. Yu.,
Leningrad Institute of Precision Mechanics and Optics

[Abstract] A study was made of a binary powder mixture pressed to a practically pore-free state. The case is analyzed in which the contact resistance to flow of thermal energy or electric charge at the boundary between particles is negligible in comparison to the resistance within the body of the particles. The overall calculation problem is reduced to three stages: calculation of the fields of concentration of impurities in the diffusion layer; calculation of local and integral diffusion layer characteristics; and calculation of the effect of conductivity of a composite, in general a 3-component system of the two initial components and a quantity component filling the volume of the diffusion layer with a combined set of properties. The model suggested for the structure and the approximate calculation method developed for the effective conductivity of a binary system with limited mutual solubility of the components can be used to predict the nature and scale of changes in properties of components of this type during annealing or operation in the planning stage. Figures 2; references 7: all Russian.
[91-6508]

ROLLING OF GRANULATED ALLOYS IN Al-Zn-Mg SYSTEM

Kiev POROSHKOVAYA METALLURGIYA in Russian No 2, Feb 82
(manuscript received after revision 1 Nov 80) pp 59-62

GORBUNOV, Yu. A., RUSOV, I. G., FEDOROV, V. M. and SOKOLOV, A. S.,
Krasnoyarsk Institute of Nonferrous Metals

[Abstract] A study was made of the rolling conditions of granules of an aluminum-zinc-magnesium-transition metal alloy poured into pans 420 mm in diameter and 1100 mm long, evacuated at 500°C for 22 hours and briquetted in a 5000 ton press. The briquettes produced were turned down, heated to 420°C and pressed from a container 450 mm in diameter into a billet 105 x 300 mm, which was then hot rolled. Compound specimens with a coordinate grid applied in the vertical plane of symmetry were rolled to determine the distribution of deformations through the height of the billets. As in the rolling of monolithic materials, the distribution of height deformations depends to a great extent on the quality of the deformation conditions which are observed. The shape index of the deformation focus in the experiments varied from 1.10 to 2.83, an area in which the influence of external zones on the rolling force is reduced, but the effect of friction is increased. The data produced can be used to select conditions of compression for rolling of pressed billets of granulated aluminum-zinc-magnesium alloys. Figures 3; references 3: all Russian.
[91-6508]

UDC: 621.762

REFLECTION SPECTRA OF HEXANITE-R POLYCRYSTALS OF VARYING PHASE COMPOSITION

Kiev POROSHKOVAYA METALLURGIYA in Russian No 2, Feb 82
(manuscript received after revision 1 Nov 80) pp 55-59

PRIMACHUK, V. L., BOCHKO, A. V., IVANCHENKO, L. A. and BALAN, T. R.,
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[Abstract] It was earlier found that the cutting properties of hexanite-R may depend on its phase composition. The authors attempted to establish the relationship between reflectivity of hexanite-R polycrystals and their phase composition. The purpose of the study was to develop a new method of nondestructive quality testing, and to determine a number of physical parameters to seek out additional factors influencing the effectiveness of tools made of this material. The surface studied was ground with diamond disks

cooled with water and then polished to class 11-12 smoothness with diamond paste, with subsequent chemical cleaning by boiling in a mixture of chrome, hydrochloric acid diluted 1:1 and distilled water. It was found that for specimens containing primarily BN_{sp} the optical characteristics agree with those known from the literature. As the relationships of the various phases BN_w , BN_{sp} and BN_h in the composition change there are changes in the reflection spectra in IR illumination resulting from differences in the interaction of light with the various crystalline lattices. IR reflectivity measurements in the $400-2000\text{ cm}^{-1}$ range can be recommended for semiquantitative determination of the phase composition of hexanite-R specimens containing not over 70% BN_{sp} . Figures 3; references 7: all Russian.
[91-6508]

UDC: 669.018.9

METHOD OF DESIGNING SELF-COOLING MATERIALS BASED ON PSEUDOALLOYS

Kiev POROSHKOVAYA METALLURGIYA in Russian No 2, Feb 82
(manuscript received 1 Dec 80) pp 38-43

VASIL'YEV, A. V., KARPINOS, D. M., KERTSER, S. A., KONDRAT'YEV, Yu. V., KUKHTAREVA, T. V. and LUZHANSKIY, G. A., Institute of Material Science Problems, Ukrainian Academy of Sciences

[Abstract] This article was intended to develop a mathematical model allowing prediction of behavior of pseudoalloys with metal cooling filler agents as a function of external conditions, and to estimate the influence of environmental parameters and type of filler on the self-cooling process. The model of the process is a boundary-value problem for heat conductivity equations with moving intermediate boundaries which transfer upon melting and evaporation of the filler within the framework. As was expected, for W+Cu and W+Zn pseudoalloys an increase was noted in the time required for the temperature level to be reached at which softening of the framework material reaches its maximum permissible value. For the W+Cu material this is related primarily to the improved thermophysical characteristics of the material, while for W+Zn it is related primarily to the absorption of heat upon evaporation of Zn as it boils. As the boiling surface moves into the framework the influence of enthalpy properties of the fillers on the surface temperature decreases. Figures 5; references 5: 3 Russian, 2 Western.
[91-6508]

REFRACTORY MATERIALS

WASTING OF REFRACTORY MATERIALS DEPLORED

Moscow RABOCHAYA GAZETA in Russian 29 Jan 82 p 2

[Article by V. Al'bokha, inspector, UkSSR People's Control Committee: "Refractories Covered With Moss"]

[Text] As we know, refractories are excellent insulators, which can stand high and ultrahigh temperatures. Equipment dressed in protective "shirts" -- blast furnaces, open-hearth furnaces, converters, batteries of coke ovens, soaking pits, heating furnaces, steam boilers, and ladles for transferring molten metal operate failure-free thanks to refractories.

Existing facilities are currently failing fully to meet the high-grade refractories requirements of the iron and steel industry. Therefore it was decided to check utilization and storage of refractory products by the metallurgical workers -- at metallurgical, coking by-product and tube rolling plants, for more than 1.6 million tons of refractories are consumed each year at these plants for maintaining heat-utilizing equipment in good working order. It is understandable that economical consumption and careful storage of refractories in this industry is of particular importance.

An inspection indicated that half of the enterprises had exceeded the specified standard refractories consumption figure per ton of steel. For UkSSR Minchermet [Ministry of Ferrous Metallurgy] as a whole, however, total overconsumption of refractories during this time amounted to 102,600 tons, representing a cost of approximately 6 million rubles. The greatest overconsumption occurred at the Dneprovskiy Metallurgical Plant imeni Dzerzhinskiy, the Dnepropetrovsk Plant imeni Petrovskiy, the Makeyevka Plant imeni Kirov, the Zhdanovsk Plant imeni Il'ich, and the Kramatorsk Plant imeni Kuybyshev. This is due primarily to the fact that these enterprises fail to observe specified furnace operating conditions, force melts, and do an unsatisfactory job of furnace care and maintenance.

At many enterprises refractories are wastefully utilized and stored, which costs the state money. Often refractories are brought in for major overhauls, but overhauls are not performed on schedule. For this reason refractories lie around unused for years. At the Plant imeni Petrovskiy, for example, two sets of refractories for overhauling blast furnace blast stoves have been lying around unused. A large part of refractories at enterprises are stored as a rule in the open air, in unsuited storage areas, and frequently simply dumped in piles. The mechanical

and physical properties of refractory products deteriorate from rain, sun and wind, and some become totally unusable. There have been numerous cases of using refractories wastefully and improperly.

UkSSR Minchermet officials receive from enterprises requests for refractories without taking into consideration ministry instructions to reuse refractories following major overhaul of metallurgical equipment. In addition, there is little regulation of production within the refractories product list. Therefore a shortage of certain items is artificially created, with an overall surplus of refractories produced from the same raw materials.

How are these materials stored and consumed at enterprises? Here are several examples. At the Dneprovskiy Metallurgical Plant imeni Dzerzhinskiy there were 20,000 tons of refractories, 70 percent of which were stored out in the open, in asphalt-paved or even unpaved dirt areas. Dirt and other loose bulk materials were dumped up against some stacks, and stacks of refractories were covered with moss and weeds. At the same time the enclosed, mechanized refractories storage warehouse was only loaded to half standard capacity. There is no ordered procedure to the storage operation. As a result 110,000 rubles worth of refractories were totally unusable.

At the Zaporozhstal' Plant 60,000 rubles worth of refractories must be scrapped as useless due to violation of GOST requirements applying to storage. In addition, there are 1052 tons of refractories at the plant which have been around so long that they are obsolete and no longer usable due to change in design of equipment components and assemblies. Existing refractories storage spaces are cluttered, and record keeping is lax. Year after year the plant fails to meet the scrap refractories delivery target, for which the plant pays thousands of rubles in fines. If Zaporozhstal' met the scrap refractories target, the neighboring plant would not be forced to haul in 15,000 tons from other oblasts, which requires the services of 250 freight cars.

At the Nizhnedneprovskiy Tube Rolling Plant imeni K. Liebknecht, 200 tons of fireclay bricks were lost through waste and inefficiency. An inspection audit revealed 730 tons of refractory bricks worth 112,000 rubles, which have been written off the books. Plant officials regularly permit overconsumption of refractories.

Wastefulness in utilization and storage of refractories, as well as selling off refractories at a loss are observed at the Dnepropetrovsk Metallurgical Plant imeni Petrovskiy, at the Zhdanovsk Plant imeni Il'ich, and at the Coking By-Product Plant and Dneprospetsstal' in Zaporozh'ye. UkSSR Minchermet, however, is not taking proper measures to put an end to all these violations and to punish the guilty parties. In addition, top supply administration officials themselves issue orders and authorizations to transfer refractory materials to other organizations.

Similar instructions were given by the deputy director of the Dneprometallosnab Association of the Dnepropetrovsk Territorial Administration of UkSSR Gossnab, L. D. Andreyev, and yet this organization should be keeping an eye on and making sure that the resources allocated to enterprises are properly stored and properly utilized. In 1980-1981 ferrous metallurgical enterprises situated in the territorial administration's operations area released without proper authorizations

more than 1000 tons of refractory materials valued at a total 60,000 rubles. In Dnepropetrovsk, for example, approximately 1000 tons of expensive fireclay bricks which were to be used for overhauling metallurgical equipment were used as finishing bricks in construction of the "Nektar" wine store.

The republic people's control committee drew the attention of the UkSSR deputy minister of ferrous metallurgy, M. Ye. Ryabchiy, to the existence of serious deficiencies in utilization and storage of refractories. The committee has been informed that the ministry has issued an order based on the inspection materials, spelling out measures to correct these deficiencies, and was also informed that a number of officials have been fined and disciplined.

As partial compensation for the losses borne by the state, forfeiture of a month's salary has been levied on the following plant deputy directors: A. Ye. Litvinov of the Dneprovskiy Metallurgical Plant imeni Dzerzhinskiy, A. I. Golovko of Zaporozhstal', and A. B. Kamenetskiy of the Nizhnedneprovskiy Tube Rolling Plant imeni K. Liebknecht. L. D. Andreyev, deputy director of the Dneprometallosnab Association of UkSSR Gossnab, has been severely reprimanded. Some officials have been brought to account by local people's control committees.

3024

CSO: 1842/77

SIALONS: NEW REFRACTORY MATERIAL

Moscow OGNEUPORY in Russian No 12, Dec 81 pp 24-28

BOYARINA, I. L., PUCHKOV, A. B., GAVRISH, A. M., ZHUKOVA, Z. D.,
Ukrainian Scientific Research Institute of Refractories, and DEGTYAREVA, E. V.,
Khar'kov Institute of Motor Vehicles and Roads imeni Komsomol of the Ukraine

[Abstract] The ability of silicon nitride to dissolve up to 60% Al_2O_3 in its crystalline lattice has resulted in the creation of a new type of material, solid solutions of metal oxides in nitrides, called sialons due to their elemental composition Si-Al-O-N. There are sialons produced by sintering, which have the properties of hot pressed silicon nitrides. The Si-Al-O-N system can be described as a quaternary system and schematically represented as a tetrahedron with the components at the points. The binary compounds are located on the ribs of the tetrahedron and retain their normal valence up to 1800°C. The temperature of synthesis of sialons by sintering decreases greatly when active materials produced in the process of heating are employed. Thus, Al_2O_3 is obtained as a result of interaction of metallic Al with silica, Si_3N_4 is produced in the process of heating of elementary Si in a medium of nitrogen. There is therefore interest in the formation of a sialon upon interaction of ammonia with kaolin at 1400°C for 22 hours. Sialon begins to form at 900°C, though the material is primarily mullite. After 1400°C the reaction product is β' sialon plus AlN. The apparent density of specimens produced by sintering at 1740°C in nitrogen is 2.92 and 3.00 g/cm³, porosity 2.9%. Sialon is not attacked by metal melts, sulfuric or hydrochloric acid, borax or alkalis and can therefore be used for the storage and transportation of melted metals, including steel. Figures 3; references 40: 13 Russian. 27 Western.

[75-6508]

STEELS

UDC 669.0.17.3

LOW TEMPERATURE DUCTILITY OF Kh18N10T STEEL BOMBARDED WITH ELECTRONS

Kiev PROBLEMY PROCHNOSTI in Russian No 1, Jan 82
(manuscript received 2 Feb 81) pp 101-102

NETESOV, V. M., Khar'kov Institute of Physics and Technology,
Ukrainian Academy of Sciences

[Abstract] An analysis is presented of deformation curves before and after bombardment of stainless steel in which martensitic conversion appears upon low temperature deformation. The material was Kh18N10T steel, a γ solid solution with dislocation density $5 \cdot 10^9 \text{ cm}^{-2}$. The specimens were deformed in the test at $3 \cdot 10^{-3} \text{ s}^{-1}$. Bombardment was by high energy electrons at 225 MeV, 80°C , $7 \cdot 10^{18} \text{ e/cm}^2$. Bombardment resulted in an increase in the strength characteristics and a decrease in ductility, with tensile strength increasing by 13% and relative elongation decreasing from 35 to 30%. A distinguishing feature of the tensile test curves of steels of this type at temperatures corresponding to intensive formation of martensite is the presence of two areas with different deformation hardening coefficients. After bombardment with electrons, the length of the first section of the deformation curve increases by a factor of almost 2, to 13%. Figures 1; references 6:

5 Russian, 1 Western.

[81-6508]

UDC: 669.14.018.29

FERRITE BOUNDARY MIGRATION KINETICS IN LOW-CARBON STEEL DURING DECARBURATION

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 1, Jan-Feb 82
(manuscript received 9 Apr 80) pp 99-101

MOVCHAN, V. I., GRUDEVA, N. A. and PODOBEDOVA, N. V., Dnepropetrovsk

[Abstract] Recrystallization processes are facilitated during diffusion decarburation of cold rolled low-carbon steel due to the sharp decrease in the number of cementite inclusions at subcritical temperatures and austenite

sections in the interval between the critical temperatures. As the time of isothermal holding increases, the growth rate of the decarburized layer decreases. The relationship of decarburization conditions to the growth conditions of columnar crystals is used in an experimental determination of the rate of grain boundary migration. The data necessary for calculation were determined experimentally on specimens of decarburized hot rolled type 08KP steel where $v=v_p$. The theory of Mott was used, applying the theory of crystal growth to study the kinetics of grain boundary displacement upon recrystallization. The coefficient characterizing the mobility of boundary atoms in the direction perpendicular to the boundary has the same order of magnitude as the coefficient of grain boundary autodiffusion. The activation energy of the process is found to be $4.8 \exp(-(32,600)/RT)$. Figures 3; references 4: all Russian.

[86-6508]

UDC: 669.14:669.778:620.179.16

ACOUSTICAL EMISSION DURING FORMATION OF FLAKES IN STEEL

Moscow DOKLADY AKADEMII NAUK SSSR in Russian Vol 261, No 5, Dec 81
(manuscript received 10 Jul 81) pp 1122-1126

IGOL'TSOV, V. A. and ISHCENKO, N. A., Donetsk Polytechnical Institute

[Abstract] The method of acoustical emission, a modern method of studying the development of fine structural processes in metals, was used to study flake formation in steel. A type AF-11 instrument was used, allowing multiparameter recording of acoustical emission signals. The object of the study was type 40KhM steel, sensitive to flake formation (composition: C-0.35, S-0.23, Mn-0.55, Si-0.035, P-0.035, Cr-0.95, Ni-0.25, Mo-0.20, V-0, W-0, Ti-0, Cu-0.10) in cylindrical form 30 mm in diameter and 60 mm in length. The specimens were saturated with hydrogen at 1050°C and $4 \cdot 10^5$ Pa for 6 hours, then cooled in oil to room temperature at 100°K/min. The thin layer scale was then removed, the end of the steel was ground and covered with vacuum grease, then placed with the sensor in a metal container on a polyurethane base. The gain was set at 94 dB and acoustical emissions were studied in a total of 5 batches of specimens for various periods of time from 1 to 20 hours. The results uniformly indicated that acoustical emissions do occur during flake formation. The emissions are discrete in nature, indicating that flake formation is discrete in nature involving complex cooperative "explosive" events. Figures 3; references 9: 8 Russian, 1 Western.

[86-6508]

INFLUENCE OF PULSED MAGNETIC FIELDS ON FATIGUE OF HIGH SPEED STEEL

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 6, Nov-Dec 81
(manuscript received 20 Jan 81) pp 8-11

POSTNIKOV, S. N., KUNGIN, A. D. and CHERNIKOV, A. A., Gor'kiy

[Abstract] As a result of artificially caused conversion of a portion of the metal to the critical state, it is shown that the influence of magnetic treatment on the fatigue of high speed steel can be significant. Cyclical testing of specimens included pulsed loading, intended to decrease plastic deformation as a result of the high speed of the deformation of the metal, thus facilitating fatigue fracture. The experiments were performed on specimens of R6M5 high speed steel subjected to a pulsed magnetic field for 50 seconds at 2 field amplitudes. The influence of magnetic processing on relative reduction in area at fracture, number of cycles for fatigue fracture and durability was determined. Durability was increased after magnetic processing, indicating a change in the fatigue response of the steel, i.e., the process of gradual accumulation of fractures. The inhibition of this process is a result of the transition of the structure of the material to a more ordered state with higher thermodynamic stability. Another reason for the increase in durability is probably an increase in surface energy.

References 10: 9 Russian, 1 Western.

[80-6508]

LASER HARDENING OF R6M5 TOOL STEEL

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 6, Nov-Dec 81
(manuscript received 3 Mar 81) pp 24-28

KUTANOV, Yu. I., BOLYCHEV, V. S., BEGISHEV, V. B., GORYUCHKIN, A. I., GORBOB, A. B. and KARELINA, V. M., Izhevsk

[Abstract] Specimens 80 mm in diameter and 4 mm thick were heat treated by heating in BaCl_2 , cooling in oil from 1230°C , double tempering in saltpeter at 550°C , holding for 1 hour, then ground to class 9 surface smoothness and irradiated with an LDU-2 laser. The wavelength of the laser was $1.06\ \mu\text{m}$, energy at least 50 J, pulse length 1.2 to 6.0 ms. The laser beam was projected onto the surface of the specimen as a 3-7 mm diameter spot. The most effective technological condition for laser treatment of the steel were determined, increasing wear resistance by a factor of 3 or more. The laser causes partial dissolution of carbides and the matrix is enriched with the alloying elements. Figures 5; references 8: all Russian.

[80-6508]

STRUCTURAL CHANGES IN ST45 SURFACE LAYERS UPON ELECTRIC SPARK ALLOYING

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 6, Nov-Dec 81
(manuscript received 21 Jan 81) pp 22-24

LARIKOV, L. N., DUBOVITSKAYA, N. V., ZAKHAROV, S. M. and SNEZHKOVA, V. A.,
Kiev

[Abstract] A study is made of the specifics of the structure of coatings on ST45 steel and the transition layer formed between the base and coating during electric spark alloying in air under three sets of conditions differing in energy and length of the spark discharge. Electrodes of chromium and ST45 steel were used. The structures were studied by diffraction electron microscopy. Before application of coatings, the base material was treated by hot rolling and cooling in air, by heating to 810-840°C, cooling in air with holding at 60°C, or by heating to 810-840°C, cooling in air and tempering at 300°C (standard, normalized and improved states). The electron microscope studies of the structure show little dependence on initial structure of the base. The studies showed that alloying with chromium produces a sublayer containing structural elements which can facilitate the formation and propagation of brittle cracks, not observed upon application of steel coatings. The formation of brittle structures results from the high temperature in the zone of action of the electric discharge, enrichment of the intermediate layer between the base and coating with chromium, which with sufficiently high cooling speeds leads to its hardening as martensite. References 12: all Russian. [80-6508]

STRUCTURAL AND PHASE TRANSFORMATIONS IN THIN In_2Te_3 FILMS DURING ANNEALING

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEORGANICHESKIYE MATERIALY in Russian
Vol 18, No 2, Feb 82 (manuscript received 25 Sep 80) pp 216-219

SOKOL, A. A., KOSEVICH, V. M. and LYUBCHENKO, Ye. A., Khar'kov Polytechnical
Institute imeni V. I. Lenin

[Abstract] A study is presented of the influence of PbTe impurities on the structural and phase transformations occurring upon recrystallization of In_2Te_3 films obtained by laser evaporation. An electron microscope was used for the structural studies. Thermal evaporation from a molybdenum boat onto KCl fracture surfaces at 470-620°K was used to apply PbTe films as spots with a mean diameter of 50 nm. Later, without reducing the vacuum, the compound In_2Te_3 was condensed at 420-620°K onto the same surface. The In_2Te_3 was evaporated by means of a solid state laser in the modulated Q mode with pulse repetition frequency 50 Hz. Laser evaporation produced films with significant phase and structural nonuniformity due to recrystallization processes which developed upon long holding in air or were activated by heat. Restructuring of the In_2Te_3 lattice from the sphalerite structure to a primitive cubic structure is thermodynamically favored when the composition of the film is altered in the direction of less tellurium due to reevaporation of tellurium when the film is heated by an electron beam and diffusion penetration of PbTe into the film of indium telluride. Figures 2; references 10:

9 Russian, 1 Western.

[94-6508]

PRODUCTION AND STUDY OF EUROPIUM AND PRASEODYMIUM THIOVANADITE THIN FILMS

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEORGANICHESKIYE MATERIALY in Russian
Vol 18, No 1, Jan 82 (manuscript received 14 Jul 80) pp 117-119

SEREBRENNIKOV, V. V., VAGANOV, Yu. F., ALEKSEYEVA, T. P. and KOZIK, V. V.,
Tomsk State University imeni V. V. Kuybyshev

[Abstract] Results are presented from a study of thin films of Eu and Pr thiovanadites. The initial material used in the experiments was europium and praseodymium thiovanadites synthesized in powder form by heating a mixture of the sulfides with vanadium sesquisulfide in vacuum quartz ampules to 1520°K and holding at that temperature for 5 hours, residual pressure 0.1333 Pa. Films were produced in an installation allowing atomization from two evaporators simultaneously, with a vibrating hopper allowing discrete feeding of the substance into the evaporator. The thickness of the films produced was measured by means of a microinterferometer and varied between 0.05 and 2 μm . Continuous thermovacuum evaporation results in decomposition of the initial compounds, but production of films close in composition to the initial substance is possible in a narrow band of evaporation temperatures between 1570 and 1720°K. The relationship between conductivity and forbidden zone width with the structure of the films produced is studied. Figures 1; references 2: both Russian.
[85-6508]

TITANIUM

ELECTROCHEMICAL TREATMENT OF LONG PARTS OF TITANIUM ALLOY IN MIXED CHLORIDE-NITRATE SOLUTIONS

Kishinev ELEKTRONNAYA OBRABOTKA MATERIALOV in Russian No 6, Nov-Dec 81
(manuscript received 2 Feb 81) pp 14-17

PETROV, Yu. N., NISTRYAN, A. Z. and SAUSHKIN, B. P., Kishinev

[Abstract] Earlier studies have established an anomalous distribution of removal of metal during electrochemical working of long parts in a long flat interelectrode channel. This phenomenon does not occur under the same conditions for specimens of other materials. Probably the change in conductivity observed in the solution over the length of the hydraulic channel is not the reason for the current redistribution observed. Apparently when titanium alloys are worked under these conditions the current distribution over the surface of the specimen is significantly influenced by such components of the voltage balance as the anode potential and the voltage drop across the film (layer) of electrolysis products. This is possible if it is assumed that titanium goes over into solution both with 4+oxidation and lower degrees of oxidation and the relative share of ions of any given types depends on the local electrolysis conditions. The results of the study allow recommendation of electrolytes containing 5 to 40 g/l of 47% HF. Experimental work has confirmed the good results achieved with the electrolyte recommended. Figures 4; references 11: 8 Russian, 3 Western.

[80-6508]

SOLID PHASE CONVERSIONS IN SURFACE LAYERS OF TITANIUM

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 1, Jan-Feb 82
(manuscript received 4 Oct 80) pp 95-98

BROVKO, A. P. and BEKMAN, I. N., Moscow

[Abstract] A radioactive inert gas label is used to study solid phase conversions in titanium occurring under linear heating conditions. During the course of the experiment the rates of liberation of radon from specimens of titanium of various purities and degrees of oxidation were measured. The experiments were performed in an inert gas, air and nitrogen. X-ray phase and neutron activation analysis methods were also used. Three types of titanium were studied: highly pure (99.99%) foil 50 μ m thick, VT1-00 titanium (99.9%) ingots and commercial VT-3 titanium powder containing about 9% oxides. The main mechanism responsible for liberation of radon was found to be volumetric ordered diffusion related to autodiffusion of metal ions. Solid phase processes occurring in the oxide layer included dehydration, phase transitions, oxidation and nitration. Phase transitions do not appear on radiograms due to the stabilizing influence of the oxides. Several types of oxide layers may exist on the surface of titanium, depending on experimental conditions. Figures 2; references 8: 6 Russian, 2 Western.
[86-6508]

UDC: 669.295:536.42

INFLUENCE OF DEFORMATION AND HEAT TREATMENT ON PHASE TRANSFORMATIONS AND PROPERTIES OF TITANIUM ALLOYS

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 1, Jan-Feb 82
(manuscript received 24 Feb 78) pp 126-219

DOLINSKAYA, L. K., MATVEYENKO, A. F. and RODIONOV, Yu. V., Moscow

[Abstract] A study was made of the influence of deformation and heat treatment on phase transformations and properties of VT22 and VT22M high strength structural titanium alloys with the addition of small quantities of copper, zirconium and tin to the latter alloy. The primary method of investigation was x-ray phase analysis, though the ultimate strength, relative elongation and reduction in area as well as impact toughness were also determined. When hardened from the β area, the VT22 and VT22M alloys had a single phase β solid solution structure with a period a_{β} = 3.239-3.24 Å, which changed upon subsequent heat treatment. The crystalline lattice periods of the α phase

depended little on heat treatment conditions. In order to preserve satisfactory ductility it is recommended that hardening heat treatment be preceded by deformation in the $\alpha+\beta$ area at about 860°C, or perhaps a bit higher under production conditions. Figures 2; references 4: 3 Russian, 1 Western.
[86-6508]

UDC: 669.295'71'297'27'28:669.017

PHASE EQUILIBRIA IN Ti-Al-Zr-W-Mo ALLOYS

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 1, Jan-Feb 82
(manuscript received 24 Nov 80) pp 130-132

VOLKOVA, M. A., NARTOVA, T. T. and MELESHKO, Ye. V., Moscow

[Abstract] A study is presented of alloys in the 5-component system Ti-Al-Zr-W-Mo along a ray with variable molybdenum content, and a polythermic cross section is constructed. The initial alloy contained 6% Al, 7% Zr, 3% W, remainder titanium. This alloy was crystallized as a β solid solution and upon cooling passed through the phase areas β , $\alpha+\beta$, $\alpha+\beta+\delta(W)$ and $\alpha+\delta(W)$. The polythermic cross section was constructed using the state diagrams of Ti-Al, Ti-Mo, Ti-Zr, Ti-W, Ti-Al-W and Ti-Al-Cr-W. Alloys were studied containing 0 to 30% Mo. The microstructure of the alloys was studied in the cast state and also after hardening from 1000, 900, 800 and 600°C. Figures 2; references 7: all Russian.
[86-6508]

UDC: 669.295:621.785.34.061

HIGH TEMPERATURE ARGON-VACUUM ANNEALING AND ITS INFLUENCE ON PHYSICAL AND MECHANICAL PROPERTIES OF TITANIUM ALLOYS

Kiev FIZIKO-KHIMICHESKAYA MEKhanika MATERIALOV in Russian Vol 17, No 6, Nov-Dec 81 (manuscript received 26 Nov 80) pp 45-49

MAKSIMOVICH, G. G., SPEKTOR, Ya. I., FEDIRKO, V. N., PICHUGIN, A. T. and KHRAMOV, S. I., Institute of Physics and Mechanics imeni G. V. Karpenko, Ukrainian Academy of Sciences, L'vov

[Abstract] A study is made of the processes involved in high temperature vacuum roasting and roasting in low pressure argon (so-called argon-vacuum roasting) and their influence on the physical and mechanical properties of certain titanium alloys. Experiments were performed on small specimens of VT1-0, PT-7M, OT4-1 titanium alloys with gage sections of 1 x 2 x 2 mm. The

studies indicated that argon-vacuum annealing, in contrast to vacuum annealing, by satisfactorily dehydrogenating the entire volume of the metal, decreases the rate of evaporation and redistribution of alloying elements, slows the development of superficial microrelief, forming a thinner and more homogeneous surface layer with altered structure, composition and properties. This influences strength and ductility, significantly improving the fatigue characteristics of the alloys both in the process of variable extension and with a small number of flexural cycles. Figures 3; references 6: all Russian.
[66-6508]

UDC: 539.43:669.715:620.191.33

KINETICS OF FATIGUE FRACTURE OF VT3-1 TITANIUM ALLOY

Kiev FIZIKO-KHIMICHESKAYA MEKhanika MATERIALOV in Russian Vol 17, No 6,
Nov-Dec 81 (manuscript received 22 Feb 81) pp 39-45

BOTVINA, L. R., YAREMA, S. Ya., GRECHKO, V. V. and LIMAR', L. V.,
Institute of Metallurgy imeni A. A. Baykov, USSR Academy of Sciences, Moscow;
Institute of Physics and Mechanics imeni G. V. Karpenko,
Ukrainian Academy of Sciences, L'vov

[Abstract] Studies are performed of the kinetics of fatigue cracks in VT3-1 alloy in a range of growth rates encompassing 5 orders of magnitude and the microrelief of fractures. A fatigue fracture diagram of the alloy and a mathematical model of fatigue fracture are constructed. The characteristics of cyclical crack resistance are determined. Data on the crack growth rates are compared with microfractographic observations. The specimens used had the following chemical composition: 5.9% Al, 2.7% Mo, 1.7% Cr, 0.5% Fe, 0.25% Si, remainder Ti. Specimens were produced by forging in the β area at 900-970°C, maximum deformation in the primary direction ~30%. Fractographic analysis revealed four stages of crack growth. The first is sensitive to alloy structure; the second leads up to the formation of the first signs of fracture; the third is characterized by an increase in the step of fatigue furrow and an increase in the fraction of static fracture elements; the fourth stage is distinguished by the development of a microrelief with pits. Figures 3; references 21: 17 Russian, 4 Western.
[66-6508]

GAS CONTENT OF SURFACE LAYERS OF WELDED JOINTS MADE OF OT4 ALLOY AFTER COMPLETE AND INCOMPLETE VACUUM ANNEALING

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 2, Feb 82 pp 49-51

MURAV'YEV, I. I., SMIYAN, O. D., KOLOMENSKIY, A. B. and ROSHCHUPKIN, A. N.

[Abstract] A study was made of the oxygen and nitrogen content of the surface layers of OT4 alloy after vacuum annealing and the change in gas content through the thickness and width of welded joints and the base metal was determined. Studies were performed on OT4 specimens cut from the base metal and the welded joint. Vacuum annealing at not over $7.65 \cdot 10^{-3}$ Pa was performed at 550 and 660°C for 2 hours, cooling with the furnace to 200°C, after which air was admitted. The gas content was studied by various methods. It was found that in the process of vacuum annealing at 660°C for 2 hours a gas saturated diffusion layer of high brittleness is formed in the surface, which may lead to early failure. The gas saturated layer formed at 550°C, 2 hours, is very thin and has no significant influence on the service characteristics of the structures. Figuree 3; references 6; all Russian.
[93-6508]

UDC 669.295

EFFECT OF SULFUR ON HARDNESS OF CAST TITANIUM

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 6, Nov-Dec 81 (manuscript received 3 Dec 80) pp 99-100

IVASHCHENKO, V. I., LISKOVICH, V. A. and GONCHAR, V. Ya., Chair of Nonferrous Metallurgy, Zaporozh'ye Industrial Institute

[Abstract] A systematic study was made to determine the effect of sulfur in raw titanium sponge on the hardness of cast metal. Sponge with an initial hardness of 100 Bhn and a known impurity+alloying content was produced in an atmosphere of sulfur vapor and an inert gas. The sulfur content was controlled, the only variable in the process. Specimens for hardness tests were produced from pressed electrodes in an electric-arc vacuum furnace. Any increase of hardness could thus be attributed to a change in the sulfur content. A computer-aided evaluation of the experimental data has yielded the relation $\Delta Bhn = 46.25 + 1577.65(S\%) - 29,642.45(S\%)^2$ for the 0.004-0.034% S. The hardness of titanium ceases to increase as the sulfur content increases above 0.01%, and titanium sulfide forms as the sulfur content reaches 0.034%. The effect of sulfur is essentially analogous to that of oxygen. Figures 1; references 3: 1 Russian, 2 Western.
[69-2415]

INFLUENCE OF GRAIN SIZE ON BRITTLINESS OF TITANIUM

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 2,
Feb 82 pp 47-48

CHERNETSOV, V. I., Northwestern Correspondence Polytechnical Institute

[Abstract] A study is made of the influence of grain size on the brittleness of titanium using technically pure titanium degassed at 750 and 950°C. The specimens degassed at 750°C maintained small grain structure; at 950°C a larger grain structure was formed. Impact toughness was determined by drop hammer testing cylindrical specimens with a circular notch. After degassing the metal specimens were hydrogenated at 750 and 950°C, producing hydrogen contents of 0.005% and 0.01%, respectively. Whereas the impact toughness of titanium depends on the quantity of hydrides precipitated rather than the absolute quantity of hydrogen contained, the variation of impact toughness as a function of grain size can be estimated on the basis of influence of grain size on hydride formation kinetics. With equal-quantities of hydrides in the metal, more favorable conditions are created in large grained metal for the formation of large hydride compounds, reducing impact toughness. The operating conditions of the material also influence the process of formation of large accumulations of hydrides. Thus, short-term impact toughness testing is insufficient for estimation of the usage conditions of titanium structures. figures 2; references 2: both Russian.
[93-6508]

REGULARITIES OF ISOTHERMAL DECOMPOSITION OF β SOLID SOLUTION IN TWO PHASE TITANIUM MARTENSITE ALLOYS

Moscow METALLOVEDENIYE I TERMICHESKAYA OBRABOTKA METALLOV in Russian No 2,
Feb 82 pp 42-47

G'YAKOVA, M. A., L'VOVA, Ye. A. and POTEKINA, T. G.,
Ukrainian Polytechnical Institute imeni S. M. Kirov

[Abstract] A study is made of conversions occurring during isothermal holding of VT3-1, VT6, VT8, VT9 and VT23 two-phase martensitic titanium alloys, super-cooled from various temperatures in the $\alpha+\beta$ and β areas. In each of these alloys, cooling from certain temperatures causes martensitic $\beta \rightarrow \alpha$ conversion. The minimum temperature, cooling from which forms the orthorhombic α "martensite phase, is called the critical temperature. The kinetics of phase

conversions were studied by x-ray structural analysis. The kinetics are described by typical C-shaped curves. Increasing the temperature of the alloy in the two-phase area leads to displacement of these curves in the direction of lower temperatures and shorter holding times. Isothermal holding of supercooled alloys in the martensite interval may result in isothermal martensitic $\beta \rightarrow \alpha$ conversion. The mechanical properties of the alloys are determined by the high temperature β phase decomposition mechanism. If the β -solid solution decomposes by a diffusion mechanism the alloy has good ductility and high strength. The optimal combination of strength and ductility with high stability of properties is achieved by isothermal holding of an alloy supercooled from the two-phase area to the temperature corresponding to the maximum rate of decomposition of the high temperature β -solid solution in the first stage. Figures 3; references 12: 7 Russian, 5 Western.
[93-6508]

UDC: 669.295:537.311.31:53.09

INFLUENCE OF PLASTIC DEFORMATION AND TEMPERATURE ON ELECTRICAL RESISTANCE OF POLYCRYSTALLINE TITANIUM

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 52, No 6, Dec 81 (manuscript received 6 Jun 80; in final version 27 Jan 81) pp 1200-1204

LAYRENT'YEV, F. F. and NIKIFORENKO, V. N., Institute of Low Temperature Physics and Technology, Ukrainian Academy of Sciences

[Abstract] A study is made of the influence of plastic deformation and temperature on the change in resistivity $\Delta\rho$ of titanium and the significance of defects in the temperature variation of $\Delta\rho$. Specimens of type VT1-0 polycrystalline titanium were prepared as cylinders 3 mm in diameter and 75 mm long and measured potentiometrically at 300 and 77°K. The nature of plastic deformation was determined to a great extent by the ambient temperature. At 300°K deformation was only by slipping, while at 77°K twinning occurred in some cases. Both $\Delta\rho$ and $\Delta\rho_d$ are functions of deformation and temperature. The experimental data produced allow estimation of the percent contribution of point and extended defects generated during plastic deformation on the resistivity of the titanium. The deviation from the Matissen rule discovered is related to a change in the effective transport cross section of scattering of electrons on crystalline lattice defects. Figures 2; references 15: 12 Russian, 3 Western.
[82-6508]

SPECIFICS OF STRUCTURE AND MECHANICAL PROPERTIES OF THICK SHEET TITANIUM ALLOY COMPOUNDS IN Ti-Al-V SYSTEM PRODUCED BY ELECTRON BEAM WELDING

Kiev AVTOMATICHESKAYA SVARKA in Russian No 1, Jan 82
(manuscript received 8 May 81, in final form 10 Aug 81) pp 26-30

GUREVICH, S. M., doctor of technical sciences, ZADERIY, B. A., SHEVCHUK, T. V., candidates of technical sciences, KOTENKO, S. S., engineer, and KHARCHENKO, G. K., candidate of technical sciences, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences

[Abstract] A study is presented of the specifics of the structure, chemical composition and mechanical properties of cast and forged titanium alloys 70 to 260 mm thick welded by electron beam welding. The chemical composition of the alloys was similar. Interstitial impurities in the alloys were present in the following quantities, %: C 0.09 [H] 0.004, [O] 0.12, [N] 0.028 (cast metal); C 0.03, [H] 0.0029, [O] 0.008, [N] 0.02 (forged). Welding was performed in a type U-736M chamber by a type UL-141 universal welding gun designed at the author's institute. The accelerating voltage was 60 kV, beam power 60 kW, effective radius 0.4 mm at 100 mm range, maximum current 1000 mA. The pressure in the chamber during welding was maintained at $6-7 \cdot 10^{-4}$ Pa. Welding was performed in the horizontal position. The welding speed was 16 m/hr for 130 mm thick alloy, 11 m/hr for 190 mm thick alloy. High quality welded seams were produced. The differences in microstructure of the welded joints, such as a narrow layer with recrystallization structure observed in the case alloy at the boundary of the base metal and the zone of thermal influence can be explained by the increased content of a stabilizer impurities and the specifics of the thermal cycle of welding. Figures 5.
[87-6508]

UDC: 546.181.1'821

INTERACTION OF TITANIUM WITH PHOSPHORUS UNDER COMBUSTION CONDITIONS

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEORGANICHESKIYE MATERIALY in Russian Vol 18, No 2, Feb 82 (manuscript received 17 Nov 80) pp 256-258

MUCHNIK, S. V., CHERNOGORENKO, V. B., IVANCHENKO, V. G., LYNCHAK, K. A. and KLIMAK, Z. A., Institute of Material Science Problems, Ukrainian Academy of Sciences

[Abstract] A study is presented of the conditions of production of titanium phosphides under combustion conditions by self-sustaining high temperature synthesis. Mixtures were prepared of titanium powder and red phosphorus with

particle size not over 56 μm . The reaction was conducted in argon at normal or elevated pressures, the initial mixtures held in quartz crucibles. The reaction was initiated by means of a tungsten spiral. The reaction products are the titanium phosphides Ti_3P , Ti_5P_3 and TiP , Ti_3P and TiP being produced as individual phases. It was found that combustion occurs both under steady and unsteady (pulsating and spin) conditions. The combustion products are formed through the liquid phase. Possible reaction mechanisms are noted. Figures 2; references 13: 8 Russian, 5 Western.
[94-6508]

WELDING

UDC: 621.791.4:539.378.3

INCREASING DIFFUSION JOINT QUALITY IN PARTS OF OT4-1 ALLOY WITH ARGON-ARC SEAMS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 2, Feb 82 pp 27-28

BOLDYREV, A. M., doctor of technical sciences, PETROV, A. S., engineer, PESHKOV, V. V., candidate of technical sciences, KUDASHOV, O. G., candidate of technical sciences, and BARSUKOV, I. I., student, Voronezh Polytechnical Institute

[Abstract] A study is made of the possibility in principle of reducing the grain size of the metal in seams obtained by argon arc welding in order to improve high temperature creep properties. This is achieved by controlling the process of crystallization of the metal in the welding bath by electromagnetic treatment and the introduction of modifiers and coolers. Studies were performed on specimens of OT4-1 alloy welded in argon on an automatic ADSV-5 machine equipped with a device producing a controlled magnetic field operating with a welding current of 250 A, a welding speed of 8.3 mm/s, and an argon flow rate 8 l/m to protect the welding bath and 4 l/m on the back side of the seam. The electromagnet was fed with a voltage of 280 V, a frequency of 3.6 Hz, a field strength of $4 \cdot 10^{-2}$ ts, and a powder flow rate of $7 \cdot 10^{-5}$ kg/s. Combined electromagnetic and modifier treatment was found to be most effective, increasing the quality of diffusion welded joints in the vicinity of joints previously welded by 30% in comparison to the previously used argon-arc welding technology. Figures 4; references 7: all Russian. [92-6508]

DEVELOPMENT OF HIGHLY EFFECTIVE WELDABLE STEELS AND EXPANSION OF THEIR PRODUCTION DURING 9TH FIVE-YEAR PLAN

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 2, Feb 82 pp 2-4

GOLOVANENKO, S. A., doctor of technical sciences, and FRANTOV, I. I., candidate of technical sciences, Central Scientific Research Institute of Ferrous Metallurgy imeni I. P. Bardin

[Abstract] At the authors' institute as new steels are developed the thermal influence of welding on the structure and properties of the zone of thermal influence is studied. Weldability studies are performed by modeling of the physical processes which occur during welding. Heat treatment by induction heating is considered a promising trend. The production of steels is increasingly widely using treatment of metals by vacuum, liquid synthetic slags, gases and powder reagents outside the furnace. Desulfuration is very significant for the production of steels with very low sulfur content. This article studies the assortment of steels widely used in the Soviet Union today, including general purpose structural steels, steels for main gas and oil pipelines, sulfur and hydrogen resistant steels, high strength low alloy steels, corrosion resistant or weldable steels and alloys for the chemical industry and machine building.

[92-6508]

UDC: 621.791.763.1:669.715

ACTUAL AREA OF MECHANICAL CONTACT DURING SPOT WELDING OF ALUMINUM ALLOYS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 12, Dec 81

(manuscript received 14 Apr 81, in final version 28 May 81) pp 43-47

RYAZANTSEV, V.I., candidate of technical sciences, Moscow

[Abstract] Experimental studies are required to determine the variation of the actual contact area as a function of compressive force and properties of the material during spot welding. The most suitable method is the printing method based on the transfer of a substance from one surface to the other. The authors used the method of carbon films with a sublayer of vaseline dissolved in carbon tetrachloride. Measurements were performed on a micro-interferometer and profilograph. It was found that a light brown film color corresponds to a 30-60 μm carbon layer thickness. The experiments showed that microcontact imprints are nonuniformly spread over the surface of the specimen. Photomicrograms are presented. With compressive forces characteristic for

contact spot welding the actual area of mechanical contact of the parts is not over 7 to 10% of the nominal area. The pressures in the areas of actual contact reach 10^9 Pa in AMts AM alloy, and $3 \cdot 10^9$ and $5 \cdot 10^9$ Pa in clad sheets of D16ATV alloy and unclad semifinished goods of D16T alloy. Figures 1; references 8: 7 Russian, 1 Western.
[68-6508]

UDC: 621.791.4.052:539.378.3.002.237

FORMATION OF JOINTS BY IMPACT WELDING IN VACUUM (ANALYTIC REVIEW)

Kiev AVTOMATICHESKAYA SVARKA in Russian No 12, Dec 81
(manuscript received 30 Mar 81) pp 31-35

SHEVCHUK, T. V., KHARCHENKO, G. K., candidates of technical sciences, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences, and KARAKOZOV, E. S., doctor of technical sciences, Moscow Evening Institute of Metallurgy

[Abstract] A new high speed method of pressure welding with heating has been developed--impact welding in a vacuum (IWV). This work presents an analytic review of studies performed at the authors' institutes concerning the physical and chemical processes occurring in the solid phase during this new high speed method of pressure welding, and also estimates the necessary conditions for production of high quality joints. The formation of a good contact and healing of defects results from localization of plastic deformations in the zone of the contact and the intensive diffusion processes which occur there. The joint formation process can be divided into two stages: the period of combined deformation of the metals being welded, and the period of cooling. During IWV of dissimilar metals, activation and setting of the contact surface may occur earlier than thermodynamically stable seeds of the new brittle phase can form in the zone of the joint. The development of atomic heterodiffusion due to anomalous ability of interstitial atoms leads to the formation of a well-developed zone of volumetric interaction in the form of a solid solution. The combination of physical processes occurring in the contact zone provides good welded joint quality. References 14: all Russian.
[68-6508]

SPECIFICS OF STRUCTURE FORMATION DURING ELECTRON BEAM WELDING OF
AL25 AND AL30 ALUMINUM ALLOYS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 12, Dec 81
(manuscript received 9 Jan 81) pp 25-30

CHERNOV, V. Yu., LOZOVSKAYA, A. V. and BONDAREV, A. A., candidates of technical sciences, Institute of Electric Welding imeni Ye. O. Paton, Ukrainian Academy of Sciences

[Abstract] A study is made of the structure and qualities of initial cast blanks and seam metals used by electron beam welding. The specifics of the cast blanks and joints were studied using AL25 and AL30 alloys obtained by various casting methods after casting in a sand mold or a metal chill mold without metallurgical treatment of the melt. Analysis of melting diagrams reveals the scheme of crystallization of the alloys, including formation of crystals of a solid solution of the alloying components in the supercooled liquid, followed by crystallization of a binary eutectic, ending in formation of ternary and more complex eutectics. In AL25 alloy, an elevated quantity of manganese was discovered in some phases, caused by its higher content in the initial metal. Electron beam welding of these two alloys, regardless of the method of production of the initial blanks of the seam metal, produces high compactness, dispersion and homogeneity of phase components in comparison to the base metal. Figures 5; references 3: all Russian.
[68-6508]

UDC: 621.791.75.052:669.15'24'26-194:620.18

INFLUENCE OF YTTRIUM ON STRUCTURE AND PROPERTIES OF CHROME-NICKEL SURFACED
METAL

Kiev AVTOMATICHESKAYA SVARKA in Russian No 12, Dec 81
(manuscript received 11 May 81) pp 6-7

ALEKSANDROV, A. G., candidate of technical sciences, LAZEBNOV, P. P. and SOVONOV, Yu. N., engineers, Zaporozh'ye Machine Building Institute imeni V. Ya. Chubar', PANFILOVA, S. Ya., candidate of technical sciences, and RASKEVICH, V. K., engineer, Ukrainian Scientific Research Institute of Special Steels

[Abstract] A study is made of the influence of yttrium on the structure, composition and content of nonmetallic inclusions and harmful impurities, and intercrystalline corrosion of surfaced metal during welding of chrome-nickel

steel type 12Kh18N10T. Specimens were surfaced and welded by standard electrodes with calcium chloride coating as well as experimental electrodes with the addition of yttrium. The yttrium was found to increase the purity of the surface metal with respect to nonmetallic inclusions and harmful impurities, facilitating a smoother transition of chromium and titanium to the metal of the seam, increasing the resistance of the chrome-nickel surfaced metal to intercrystalline corrosion. Figures 2; references 4: all Russian.
[68-6508]

UDC: 621.791.754'293.052:669.255:620.17

PROPERTIES OF HEAT RESISTANT COBALT SURFACED METAL WITH VARIOUS ALLOY SYSTEMS

Kiev AVTOMATICHESKAYA SVARKA in Russian No 1, Jan 82
(manuscript received 14 Mar 81, in final form 3 Aug 81) pp 48-51

SOROKIN, L. I., LAZ'KO, V. Ye., candidates of technical sciences, and
KOVAL'CHUK, V. G., engineer, Moscow

[Abstract] A study was made of the influence of tungsten, nickel and iron on the properties of welded alloys in the system Co-Cr-Ni-W , as well as the influence of aluminum, titanium, boron and REM on the properties of the surfaced metal in order to select the most suitable compositions for these alloys. Experimental ingots with a mass of 10 kg were produced in a vacuum-induction furnace and poured through a siphon, and then deformed after mechanical working to produce plates 2 and 12 mm thick. After etching, the 2 mm thick plates were broken into bars 2 x 2 mm, used for argon arc multilayer surfacing in a copper mold as well as butt welding of the 12 mm thick plates. Microsections and circular specimens were prepared to determine the strength and ductility. Tungsten (up to 8-10%) and yttrium or cerium (up to 0.05%) are suitable to increase heat resistance and hot crack formation resistance of the cobalt-chromium-nickel surfaced metal. Introduction of iron helps to increase ductility, but decreases heat resistance and hot crack formation resistance. Aluminum, titanium and boron decrease ductility and resistance to hot crack surface formation. Figures 3; references 5: all Russian.
[87-6508]

SOME PROBLEMS OF QUALITY ASSURANCE IN CONTACT SPOT WELDING OF ALUMINUM ALLOYS BY ELECTROMAGNETIC METHOD

Kiev AVTOMATICHESKAYA SVARKA in Russian No 1, Jan 82
(manuscript received 14 Apr 81, in final form 14 May 81) pp 59-62

RYAZANTSEV, V. I., candidate of technical sciences, Moscow FASTRITSKIY, V. S., FISHKIN, P. S., candidates of technical sciences, Riga, KLIMOVA, I. I., engineer, Saratov, and FEDOSEYEV, V. A., engineer, Moscow

[Abstract] A list of usable nondestructive testing methods for defectoscopy of joints produced by contact spot welding is presented: gamma graphic, thermographic, ultrasonic, x-ray, static and electromagnetic. Most of these methods are slow and unreliable or uneconomical. The authors studied the effectiveness of the electromagnetic method, a comparatively inexpensive and rapid method. Structural changes in the vicinity of welded spots result in significant changes in conductivity, allowing the use of this method. The DST-5 and DST-6M instruments which have been developed allow reliable testing of the quality of spot welds in D16T, AMg6 and AMtsAM alloys. The electromagnetic method of quality assurance of spot welds allows a great reduction in the amount of x-ray testing required for important units. Figures 3; references: 1 Russian.
[87-6508]

UDC: 621.791:021.38

WELDED SEALED CONTAINER FOR SPACE RADIO TELESCOPE

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 12, Dec 81 pp 30-31

REZNICHENKO, V. F., candidate of technical sciences, MEL'NIKOV, V. P., SHAROV, V. M. and KORYAKOV, Ye. V., engineers

[Abstract] The idea of creation of a space radio telescope was first successfully implemented in 1979 on the Salyut-6--Soyuz-34 system by the USSR. The KRT-10 orbital radio telescope with 10 meter antenna consisted of a parabolic reflector, focal sealed container with automatic temperature regulation system and antenna aiming equipment. Successful operation of the device largely resulted from the reliability of the system which protected the instruments in the sealed container from the conditions of space. The sealed container is a complex welded and soldered structure which is diagrammed in this article. It consists of AMts alloy, selected for its strength, vacuum tightness and ease

of working. It was produced with a specialized automatic argon-arc welding installation which is also diagrammed in the article. The installation includes an automatic welding wire feeding mechanism, manipulator, control panel and power supply.

[64-6508]

UDC: 621.791.754-982

DEVELOPMENT OF VACUUM SURFACING AND ARC WELDING PROCESSES

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 12, Dec 81 pp 16-17

YAMPOL'SKIY, V. M., doctor of technical sciences, Moscow Higher Technical School imeni N. E. Bauman

[Abstract] It is desirable to use the effectiveness of vacuum protection and the properties of an electric arc as the energy source to create a method of arc welding by fusion in a vacuum. Processes of arc welding and surfacing in a vacuum have been studied since 1961 at the author's school. This article describes the results of some of these studies. Results have demonstrated that a vacuum arc is stable at pressures of $5 \cdot 10^{-5}$ to $1 \cdot 10^{-1}$ mm Hg. Results with fusible electrodes have demonstrated the possibility and principles of vacuum arc welding. A number of forms of arc discharges can be produced in a vacuum allowing welding and surfacing to be performed for a broad range of materials, thicknesses and conditions. Both laboratory and industrial application of vacuum arc welding and surfacing show that the processes developed are simple, convenient, safe and economical.

[64-6508]

UDC: 621.791.72:621.373.826

LASER WELDING OF METALS

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 12, Dec 81 pp 14-16

GRIGOR'YANTS, A. G., doctor of technical sciences, Moscow Higher Technical School imeni N. E. Bauman

[Abstract] Studies performed in the Department of "Machines and Automation of Welding Processes" at the author's school and other organizations have allowed lasers to be used to weld structural steels and other alloys. The condition of the surface influences the effectiveness of laser welding. However, with all surface conditions the optimal welding conditions can achieve productivities of $3.5 \cdot 10^{-2}$ m/s for steels and up to $5.0 \cdot 10^{-2}$ m/s for titanium

alloys. The results of calculations and later experiments have established the specifics of distribution of temperatures during laser welding, represented by very high temperature gradients and cooling rates in the area of crystallization of the metal in the welding bath and decomposition of austenite. Extensive studies have been performed at the author's school on determination of the deformation capability of seam metals produced by laser welding. The impact toughness of the seam metal is equivalent to that of welded seams produced by electron beam and argon arc welding methods. The author's school is now testing various laser welding installations, for example one for welding of crank shafts which significantly improves both joint quality by a reduction of deformation and productivity of the process. Figures 2; references 8: all Russian.
[64-6508]

UDC: 621.791.052:539.4

ESTIMATE OF EFFECTIVENESS OF WELDED JOINTS IN THINWALL VESSELS OPERATING UNDER PRESSURE

Moscow SVAROCHNOYE PROIZVODSTVO in Russian No 12, Dec 81 pp 6-9

KURKIN, S. A., doctor of technical sciences, and DANILOV, G. I., engineer, Moscow Higher Technical School imeni N. E. Bauman

[Abstract] In order to determine the dimensions of cracks capable of growing from a defect within the operating life of a vessel and estimate their critical nature, approaches from fracture mechanics were used. An experimental study was performed of the process of conversion of a surface defect to a penetrating crack by construction of nomograms convenient for timely determination of the critical dimensions of defects discovered during quality control. The tests were performed on flat specimens with butt welded joints 3.3 and 4.75 mm thick and 100 mm in width. Flat defects were imitated by surface notches produced by a disk milling cutter 0.2 mm thick; body defects were imitated by nonpenetrating drilled apertures 0.6-0.7 mm in diameter. The method of experimental investigation of the process of transformation of a surface defect to a penetrating crack is rather general in nature and can be used to study the efficiency of welded joints of shell structures made of various materials. The nomograms suggested can be used to determine critical dimensions of defects found during quality control inspections from the standpoint of eliminating leakage within the operating life of a vessel. Figures 3; references 7: 6 Russian, 1 Western.

[64-6508]

MISCELLANEOUS

SPACE-AGE METALS REVIEWED

Moscow AVIATSIYA I KOSMONAVTIKA in Russian No 1, Jan 82 pp 44-45

[Article by N. Kon'kov: "Space-Age Metals"]

[Text] The Metallurgy Pavilion at the Exhibit of Achievements of the National Economy of the USSR is truly a world of metal. A group of visitors slowly walks along the topical displays entitled "New Equipment and Materials of the Rare Metals Industry," "Refractory Metals," and "Rare Scattered Elements," listening with interest to the commentary of pavilion methods specialist Larisa Grigor'yevna Pogorelaya.

"You have all seen the monument to the conquerors of space," she said. "But of what kind of metal is the monument made? Of titanium. This metal possesses exceptional chemical stability: it is unaffected by humid air, seawater, and acids. Centuries will pass, but the monument's metallic luster will not dull. What is the secret of this stability? Scientists say that it is due to strength of an oxide film. Titanium is a metal of our times. Its utilization is constantly expanding. That time is probably not far off when we shall see an automobile with a body of high-strength, non-corroding titanium alloy. Such a body will weigh half as much as a body fabricated of sheet steel."

V. I. Lenin called iron one of the foundation stones of civilization. And this metal still remains today the principal material of modern technology. Iron and its alloys are used in building hydroelectric power stations, power transmission line towers and rail lines, frames of buildings and bridges, automobiles, trucks and tractors, airplanes and rockets. At the same time other metals are becoming increasingly important in the aerospace industry and in electronics.

Aluminum rightly stands at the head of the list. The skin of our first artificial earth satellite, for example, was fabricated of aluminum alloys. Many aluminum alloys are equal in strength to medium-alloy steel. Particularly valuable is the fact that some aluminum alloys retain their strength not only at Arctic temperatures but can also withstand the deep cold of space. As we know, in space, as one moves further away from the Earth and Sun, temperature in the shade reaches -200°C .

Aluminum, however, is by no means the lightest metal. Silvery-white magnesium is one third again lighter than aluminum and is only 22 percent as heavy as steel. The specific strength of magnesium alloys is greater than that of aluminum. Magnesium is primarily used as a component of light alloys. Some, an alloy of

lithium with magnesium, for example, are even lighter than water. Many components of modern aircraft, aircraft engines, rockets, and satellites are made of magnesium alloys.

A special display section in the Metallurgy Pavilion bears the title "Refractory Metals." Here we learn about the amazing properties of beryllium. This is a hard metal which melts at 1284°C, while the melting point of aluminum and magnesium is half that. A very important point is that beryllium, while one and a half times lighter than aluminum, is at the same time stronger than many specialty steels. It combines lightness, strength and rather high heat resistance, that is, it does not lose its properties right up to temperatures of 700-800°C.

Structural stiffness is important in aircraft. It is not surprising that one visitor asked the following question: "Does beryllium maintain this property at high temperatures, and in conditions of vibration?"

"It certainly does," replied Larisa Grigor'yevna. "In addition, beryllium imparts to alloys hardness, strength, heat resistance and resistance to corrosion. While highly heat-resistant, its thermal conductivity is seven times that of steel, and it is superior to all other metals in specific heat."

We shall not repeat the entire contents of the discussion of this space-age metal. We shall discuss only two of the facts covered by Larisa Grigor'yevna. Thanks to high thermal conductivity and specific heat, an engine exhaust nozzle made of beryllium can withstand temperatures up to 3000°C. And this makes it possible substantially to increase engine thrust and decrease engine weight. In the final analysis aircraft weight is also reduced. Here is another fact. This metal is generally acknowledged to be the best material for spacecraft antennas. An optical telescope mirror made of beryllium will be 5 times lighter than a conventional mirror mounted on the earth's surface.

Modern technology also needs materials capable of withstanding high temperatures under considerable loads. As we know, aircraft engine turbine blades presently operate at temperatures of 1100°C and higher. Refractory metals -- chromium, molybdenum, and tungsten -- are used as the base metal in developing even higher-temperature materials. A tantalum alloy with tungsten and hafnium, for example, retains high strength at 2000°C and does not become brittle even when cooled to a temperature close to absolute zero. At the same time this alloy is easily workable and weldable.

"Note these items made of vanadium -- tubes, sheets, rods, wire," the guide points out. "One can scarcely exaggerate the role of this metal in modern technology. A melting point of about 1900°C, resistance to oxidation when heated to 600°C, high plasticity, comparatively low specific weight and other physical properties make vanadium and vanadium alloys promising structural materials. Vanadium is an important alloying element. Thanks to vanadium, more than 200 grades of steel obtain their unique properties. For example, if we add a few grams of vanadium powder to a ton of carbon steel, its strength will increase by almost one third. Literally a grain of vanadium powder makes steel extremely resistant to cold. Castings and forgings of vanadium alloys are employed in aircraft, rockets and nuclear power equipment."

At the "Rare Scattered Elements" display, the guide mentioned cesium.

"This is a very rare element," explained Larisa Grigor'yevna. "In addition, it is highly dispersed in the natural state. It is used in TV picture tubes and lasers. In ion rocket motors cesium is used as a working medium: it is transformed into ionized gas, which is accelerated by an electric field to high velocity and is ejected from the rocket nozzle. This produces the motor's thrust. Photocells are one of the principal applications of cesium."

The group moves on to the next display -- "Semiconductor Materials and Compounds."

"Germanium produced a genuine revolution in radio electronics," states the guide. "Germanium and silicon are the foundation of semiconductor technology. In the age of nuclear energy and conquest of space, advances in such fields as radio electronics, automatic control, computer technology and rocketry, television and remote control are inconceivable without diodes and triodes. They are highly efficient, consume little power, are highly reliable, are small in size and light in weight. In addition, they have a long service life. You see displayed here a portable electronic computer and a miniature radio...."

Stopping by a model of a "Redmet-15" [Rare Metals-15] unit, the guide explains the process of growing a single silicon crystal. The Soviet Union possesses a strong synthetic crystal industry. Single crystals of fianite, based on zirconium and hafnium oxides, enjoy deserved recognition both in this country and abroad. A team of scientists at the Physics Institute imeni P. I. Lebedev of the USSR Academy of Sciences (FIAN) was awarded the Lenin Prize for their development.

Thanks to advances in solid-state physics and chemistry, as well as employment of computers, scientists predict the properties of not yet produced alloys and metal compounds. These will include substances with special, sometimes unique properties, substances essential to new technology: for example, superconductors capable of retaining this property at relatively high temperatures, permanent magnets with unparalleled characteristics, alloys of nickel with titanium capable of remembering the shape and precise dimensions of items fabricated of them.

"Imagine," says the guide, "a spacecraft antenna made of such an alloy. During launch the antenna is coiled up, in order to take up as little space as possible. Once in space, heated by the rays of the sun, it assumes the shape which it was imparted on earth. Not only compounds of nickel with titanium, but certain other alloys as well possess this mechanical memory effect."

Utilizing experimental conditions of obtaining and processing metals and alloys (for example, high and ultrahigh temperatures, ultrahigh pressures and the vacuum of space, various radiations and high-energy particles, powerful electric, magnetic, and ultrasonic fields, weightlessness), one can discover new phenomena and properties of materials which escape observation under normal conditions.

The tour continues. The pavilion display devotes considerable attention to ferrous metallurgy -- one of the basic branches of industry. In close conformity with the fundamental documents of the 26th CPSU Congress, "Basic Directions of Economic and Social Development of the USSR in 1981-1985 and the period up to 1990," the display

shows trends in development of this branch and its future growth and improvement prospects: radical improvement in quality and increased output of efficient metal products, extensive technical retooling of ferrous metallurgical enterprises. The blast-furnace process is replaced with direct reduction of iron from ore, bypassing the blast furnace.

"The Soviet Union is building a huge electrometallurgical complex in Staryy Oskol," explains the guide, "the world's first. Production is based on a blast-furnaceless process, and subsequent steelmaking is based on application of such advanced methods as arc-furnace steelmaking and vacuum processing of metal. Unique Soviet continuous casting machines will be utilized."

Retooling of the iron and steel industry involves improving converters -- steel-making equipment which is gradually replacing open-hearth furnaces. The guide explains the technical idea behind converters in concise fashion: "Pig iron is converted to steel with the aid of pure oxygen blown through the charge. Impurities simply burn up. It is more economical than the open-hearth process, its output is higher, and operating costs are much lower."

We approach a model of the famed Novolipetskiy Metallurgical Plant. The guide draws our attention to one of the combine's principal points of interest -- Shop No 2, where continuous casting of converter steel is conducted with the aid of huge 350-ton ladles. We ask: what are the advantages of continuous casting?

"Eliminating intermediate stages, we obtain billets directly from molten metal," the guide replies.

The pavilion displays persuasively attest to the fact that all the thoughts of our metallurgical workers are focused on successful accomplishment of the targets of the current five-year plan and the tasks specified at the 26th CPSU Congress.

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UDC: 621.793:669.27'849

DIFFUSION STAGE OF CHEMICAL PRECIPITATION OF TUNGSTEN-RHENIUM ALLOYS

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEOGRANICHESKIYE MATERIALY in Russian
Vol 18, No 1, Jan 82 (manuscript received 31 Oct 80) pp 66-68

LAKHOTKIN, Yu. V. and KRASOVSKIY, A. I., Institute of Physical Chemistry,
USSR Academy of Sciences

[Abstract] An analysis is presented of the diffusion stage of precipitation of W-Re alloys from a mixture of their hexafluorides with hydrogen based on kinetic data presented in an earlier work by the authors. Due to the low rate of precipitation of the alloys, the variation in diameter of the reactor during the experiments was ignored and the concentration of the components in all cross sections of the reaction zone considered steady. Studies of the kinetics of precipitation of W-Re alloys showed that the rate of precipitation of Re when coprecipitated with tungsten at 823°K is controlled by the diffusion of ReF_6 to the substrate. The maximum growth rate of the alloys should be observed with a molar fraction of fluorides of 0.7. The model suggested agrees with the experimental kinetic data. Figures 1; references 4:

1 Russian, 2 Western.

[85-6508]

UDC: 542.65

CRYSTALLIZATION OF PHASE Ta_3Sn WITH Al_5 STRUCTURE AT HIGH PRESSURE

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEOGRANICHESKIYE MATERIALY in Russian
Vol 18, No 1, Jan 82 (manuscript received 11 Oct 80) pp 62-65

KALYAYEVA, N. V. and POPOVA, S. V., Institute of High Pressure Physics,
USSR Academy of Sciences

[Abstract] A study is made of the superconducting properties of Ta_3Sn specimens with Al_5 structure, synthesized from the initial elements at high pressure, as a function of the unit cell period and degree of ordering of the

crystalline lattice. Synthesis was performed at a constant pressure of 7.7 GPa in the 1070-1670°K temperature interval. Tantalum containers were used which also served as heaters, as well as hollow cylinders of Al_2O_3 in which heating was performed by transmission of alternating current through the reaction mixture. The specimens synthesized were studied by x-ray diffraction in filtered Cu K_α radiation. The variation of long range order parameter S as a function of temperature was determined. High pressure was found to accelerate crystallization of ordered phases having higher transition temperatures to the superconducting state. Figures 2; references 9: 1 Russian, 8 Western.
[85-6508]

UDC: 621.793

EMISSION PLASMA COATINGS BASED ON LaB_6

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEORGANICHESKIYE MATERIALY in Russian Vol 18, No 1, Jan 82 (manuscript received 17 Jun 80) pp 44-46

KONDRASHIN, A. A., CHERNYAYEV, V. N., KORZO, V. F. and BLOKHIN, V. G.,
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[Abstract] The use of pulsed plasma accelerators is quite promising for the production of high quality thermal emission coatings of rare earth elements, yielding deposition rates of up to $5 \cdot 10^3$ nm/s, 10-100% ionization and 20-50% utilization of the evaporated material, good accuracy of testing based on mass of evaporated material and great cleanliness of the technological process. A process pulsed plasma accelerator was produced on the basis of an UVN-2M-3 installation. Films of LaB_6 were precipitated onto refractory metal (W, Ta, Mo) foils and sital or polycor substrates. The emission characteristics were studied. The work function of a cathode based on W and Ta was 2.4 and 2.55 eV (substrate temperature 670 K, film thickness 1 μm , discharge current 1 kA, discharge pulse length 0.7 ms, number of precipitation pulses 10,000). An electromagnetic separator is used to separate drop and vapor ionized parts of the plasma stream. The possibility is demonstrated of creating refractory emission plasma coatings with reduced work function. Figures 2; references 11: 9 Russian, 2 Western.
[85-6508]

INFLUENCE OF ENVIRONMENT ON DEFORMATION AND FRACTURE UPON CREEP OF
EP782 NICKEL ALLOY

Kiev PROBLEMY PROCHNOSTI in Russian No 2, Feb 82
(manuscript received 27 May 81) pp 52-55

TSVILYUK, I. S., PYL'NIKOV, V. I., RASTORGUYEVA, I. A. and AVRAMENKO, D. S.,
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[Abstract] An attempt is made to estimate the influence of the environment (air, high and superhigh vacuum) on the deformation and failure of EP782 nickel alloy under creep conditions (9.76 Mo, 2.29 Nb, 1.66 Al, 6.72 Fe, 10.68 Cr, 0.6 Mn, 0.1 C, 0.08 Si, 0.007 P, 0.006 S, remainder Ni). The material was studied as delivered, after heating to 1323°K for 15 minutes and cooling in air. It was found that the environment has a significant influence on deformation and fracture. The heat resistance characteristics in the vacuum are reduced in comparison to the characteristics in air. Therefore, the values of strength properties of structural materials produced in tests in air cannot be used for the design of equipment for use in a vacuum. Figures 5; references 7: 2 Russian, 5 Western.
[95-6508]

UDC: 621.039.531

ESTIMATE OF THERMAL FATIGUE DAMAGE TO HIGH STRENGTH MATERIALS UPON NEUTRON
BOMBARDMENT

Kiev PROBLEMY PROCHNOSTI in Russian No 2, Feb 82
(manuscript received 15 Jul 80) pp 55-61

MALYGIN, A. F., NIKOLAYEV, V. A. and KURSEVICH, I. P., Leningrad

[Abstract] An attempt is made for the first time to estimate the thermal cycling strength of materials of various structural classes in the semi-brittle and macroscopically brittle states upon bombardment by fast neutrons with energies of at least 0.1 MeV, fluence 10^{23} n/cm². These estimates are difficult due to the development of a number of structural processes such as negative and radiation creep, delayed fracture, etc. in the materials which have been little studied. Thermal fatigue damage to high strength reactor materials was estimated both using data from direct long term testing of bombarded specimens in cyclical nonisothermal tension compression and the results of the corresponding studies of their physical and mechanical properties and structural parameters. Bombarded dispersion-hardened chrome nickel steel is used to show the possibility of estimation of long term thermal cycle strength

by calculation based on the deformation criterion of thermal fatigue fracture using temperature-time and dose dependence of mechanical properties and structural parameters. Equations are derived defining the temperature-time variation of strength and ductility of high strength materials of various structural classes under fast neutron bombardment. It is shown that high temperature neutron bombardment causes processes of radiation hardening, annealing, embrittlement and temperature softening. The decrease in the long term thermal cycle strength of high strength materials under the conditions used may be by a factor of 2 to 10. Figures 4; references 7: 6 Russian, 1 Western.
[95-6508]

UDC: 621.791.76:621.7044.2(088.8)

HARDENING OF MATERIALS UPON HIGH SPEED COLLISION

Tbilisi SOOBSHCHENIYA AKADEMII NAUK GRUZINSKOY SSR in Russian Vol 103, No 3, Sep 81 (manuscript received 24 Jul 81) pp 665-668

CHKHARTISHVILI, I. V., ZARKUA, R. Sh. and OKLEY, L. N., corresponding member, Georgian Academy of Sciences

[Abstract] A study is made of hardening as a function of collision velocity for bimetallic materials. Collision velocity varied from 200 to 2200 m/s. The increase in microhardness was represented by the dimensionless relative hardening following collision. Relative hardening as a function of collision is represented by a curve with clear extreme points. They are critical values of collision velocity which determine the variation of relative hardening as a function of collision velocity. The curve shows initial low hardening, an increase through a maximum, a decrease through a minimum at approximately the same level as the initial low velocity value, followed by another slight increase. Experiments are required to determine the critical velocity at which relative hardening is maximized. The degree of hardening is not distributed uniformly between the moving and fixed plates; their hardening curves cross at the high velocity point of low hardening. Figure 1; references 2: both Russian.
[90-6508]

STRUCTURAL CERAMIC MATERIALS

Moscow STEKLO I KERAMIKA in Russian No 2, Feb 82 pp 18-19

KARPINOS, D. M., doctor of technical sciences, KALINICHENKO, V. I., candidate of technical sciences, GUMENYUK, Ye. L. and GOLOVACH, A. G., engineers, Institute of Material Science Problems, Ukrainian Academy of Sciences; Ukrstroykeramika; Dnepropetrovsk State University

[Abstract] Ceramic materials are little used in machine building due to their low impact strength and resistance to thermal shocks. Elimination of these shortcomings could allow significant expansion of the area of application of ceramics. Reinforcement of ceramic materials with fiber components can eliminate their most important shortcomings as structural materials. In such materials loads are transferred from the brittle materials to the stronger elastic fibers. Reinforcement of ceramics with metal whiskers increases thermal stability but decreases the mechanical strength due to the difference in elasticity moduli and coefficients of linear expansion. The optimal solution is reinforcement of ceramic matrices with ceramic fibers such as those based on oxides and oxygen-free compounds such as BN, AlN, SiC, Si_3N_4 , B_4C and graphite.

[89-6508]

UDC: 541.123.2:546.719.681.94

NEW PHASES IN SYSTEMS Re-Ga AND Os-Ga OBTAINED AT HIGH PRESSURE

Moscow IZVESTIYA AKADEMII NAUK SSSR: NEORGANICHESKIYE MATERIALY in Russian No 18, No 2, Feb 82 (manuscript received 9 Feb 81) pp 251-255

POPOVA, S. V. and FOMICHEVA, L. N., Institute of High Pressure Physics, USSR Academy of Sciences

[Abstract] A study is made of the possibility of formation of Re and Os gallides under pressure and it is shown that the pressure facilitates the formation of new phases in these systems. Studies were performed at a constant pressure of 7.7 GPa and a temperature range 570-1170°K in cylindrical heaters of Nb, Ta and Mo. The pressure transmission medium was catlinite. The specimens produced were studied by x-ray diffraction, and production of debye diagrams in filtered CuK_α radiation. It was found that at high pressure the interaction of Re and Os with gallium leads to the formation of new compounds in these systems: α and β ReGa_3 and a superconducting phase with

HCP structure and critical temperature of 4 K. New gallides were also produced under pressure in the system Os-Ga:Os-Ga₃ and OsGa₂. Figures 2; references 8: 4 Russian, 4 Western.
[94-6508]

UDC 669.293.018.85:620.17

EFFECT OF ALLOYING ON HEAT RESISTANCE OF NIOBIUM-TITANIUM-ALUMINUM ALLOYS

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 6, Nov-Dec 81 (manuscript received 19 Jan 81) pp 71-74

TRQITSKIY, B. S., ZAKHAROV, A. M., VERGASOVA, L. L. and VLASOV, P. N.,
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[Abstract] An experimental study was made to determine the effect of adding vanadium (2-10%), chromium (1-5%), zirconium (2-10%), molybdenum (5-10%), hafnium (2-10%), and tantalum (5-15%) on the heat resistance of the VN-7 niobium alloy. Specimens were produced by multiple remelting of 80-100 g ingots in an electric-arc furnace, and their heat resistance was evaluated by continuous weighing of ground disk samples at 1100, 1200, 1300°C in still air. Chromium, hafnium and tantalum decreased the oxidation rate by a factor of 1.2-1.6, while molybdenum, vanadium and zirconium increased the oxidation rate by a factor of 7-8 at those high temperatures. The scale layer forming on the surface of this niobium-titanium-aluminum alloy consisted of two phases, tetragonal TiO₂ and monoclinic TiO₂·Nb₂O₅, with which aluminum as well as the other elements form a solid solution instead of forming their own oxides. Figures 2; references 6: 5 Russian, 1 Western.

[69-2415]

UDC 669.27:621.357.1

ELECTROCHEMICAL DISSOLUTION OF RHENIUM AND VR-20 ALLOY IN SOLUTIONS OF SODIUM HYDROXIDE

Ordzhonikidze IZVESTIYA VYSSHIKH UCHEBNYKH ZAVEDENIY: TSVETNAYA METALLURGIYA in Russian No 6, Nov-Dec 81 (manuscript received 3 Feb 81) pp 38-41

GURIIYEV, R. A., Chair of General Metallurgy, North Caucasian Institute of Mining and Metallurgy

[Abstract] Scrap of tungsten-rhenium alloys is efficiently reprocessed by anodic dissolution in alkaline electrolytes. An experimental study was made of electrochemical dissolution of rhenium and its VR-20 alloy with direct and

alternating current in NaOH solutions. With direct current rhenium has been found not to become passivated, except at very high current densities, but the anode to become corroded due to polarization. The experimental data were evaluated through a nonlinear regression analysis and the results compared with industrial experience. The dissolution rate with direct current does not depend much on the electrolyte concentration and temperature, but increases with increasing current density. Dissolution with alternating current occurs only above a threshold current density, which depends on the electrolyte concentration and temperature; at much lower for rhenium in the VR-20 alloy than for a rhenium electrode. This establishes the feasibility of avoiding electrode polarization, namely by the use of alternating current, even with very low NaOH concentrations and at very high current densities. Figures 3; references 9: all Russian.
[69-2415]

UDC: 621.762.5.001:539.4.42:620.18

EXPERIMENTAL OBSERVATION OF SHAPE MEMORY AND VOLUME MEMORY EFFECTS IN POROUS NICKEL-TITANIUM MATERIAL

Kiev DOKLADY AKADEMII NAUK UKRAINSKOY SSR, SERIYA A: FIZIKO-MATEMATICHESKIYE I TEKHNIЧЕСKIYE NAUKI in Russian No 12, Dec 81
(manuscript received 27 Feb 81) pp 84-87

MARTYNova, I. F., SKOROKHOD, V. V. and SOLONIN, S. M., Institute of Material Science Problems, Ukrainian Academy of Sciences

[Abstract] A study is made of the possibility of realization of the shape memory effect in a porous material obtained by sintering a mixture of nickel-titanium powders with a volatile powder-forming agent. The diffractogram of the material produced was practically identical to that of titanium nickelide obtained by traditional casting. Results are presented from determination of the degree of deformation upon recovery and completeness of shape recovery upon heating of the specimens after deformation with various degrees of macroscopic deformation. It is found that the completeness of recovery in all cases is significantly less than for nonporous materials. This is explained by the fact that even with small macroscopic deformations, there are local areas in the porous body with higher degrees of deformation, exceeding the amount of reversible deformation. However, the processes of shape recovery occurring in microscopic volumes of the metal do achieve recovery of the volume of the body as a whole. Figures 1; references 2: both Russian.
[76-6508]

CRYSTALLOGEOMETRIC CHARACTERISTICS OF ORDERED MODIFICATION OF TITANIUM MONOXIDE WITH ~54% ATOMIC OXYGEN CONTENT

Kiev DOKLADY AKADEMII NAUK UKRAINSKOY SSR, SERIYA A: FIZIKO-MATEMATICHESKIYE I TEKHNIЧЕСKIYE NAUKI in Russian No 12, Dec 81
(manuscript received 15 Jun 81) pp 71-74

ARBUZOV, M. P., corresponding member, Ukrainian Academy of Sciences,
KHAYENKO, B. V. and KACHKOVSKAYA, E. T., Institute of Metallography,
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[Abstract] A detailed study is presented of the structural states achieved in TiO_x by means of highly sensitive x-ray diffraction methods of examination of single crystals. The specimens were produced by remelting of iodide titanium and an oxygen-containing master alloy in an arc furnace. The studies were performed by the Debye method of finely ground powders and on fragments of alloys in filtered and monochromatic $CuK\alpha$ radiation. The data indicate that the ordered modification described in this work is achieved in a composition corresponding to the upper boundary of the nominal area of homogeneity of TiO_x . The crystallogometric characteristics of the phase (cubic symmetry with $a=5a_{NaCl}$) do not agree with those reported in earlier works, but the authors conclude that they have indeed achieved the same modification, the difference lying only in the difference of method of description of the superstructure of the unit cell. Figures 1; references 8: 4 Russian, 4 Western.
[76-6508]

UDC: 669.15'24'25:536.42:53.096

TRANSFORMATIONS UPON HEATING IN Fe-Ni-Co ALLOYS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 52, No 6, Dec 81
(manuscript received 16 Jun 80, in final version 27 Jan 81) pp 1323-1326

ZVIGINTSEV, N. V. and ZVIGINTSEVA, G. Ye., Ural Polytechnical Institute imeni S. M. Kirov

[Abstract] Continuing earlier studies, results are presented from an investigation of the influence of the addition of 10% Co to conversions upon heating in alloys containing from 25 to 31% Ni. The alloys were produced in an induction furnace with sequential alloying. The behavior of $I(t)$ curves depends essentially on the composition of the alloy. In addition to effects resulting from heat liberation upon formation of near order and absorption of heat with α to γ transformation, the curves of changing heat capacity also show an

anomaly related to a decrease in C_p at around 515°C. It is found that one must consider the influence of atomic redistribution on the characteristics Δl and I in studying Fe-Ni-Co alloys. Figures 4; references 12: 9 Russian, 3 Western.

[82-6508]

UDC: 669.15'24:536.413.2

REGULATING COEFFICIENT OF LINEAR EXPANSION OF IRON-NICKEL INVARS WITH FCC LATTICE

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 52, No 6, Dec 81 (manuscript received 26 Jan 81) pp 1320-1323

SAGARADZE, V. V., SHABASHOV, V. A., YURCHIKOV, Ye. Ye. and KABANOVA, I. G.,
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USSR Academy of Sciences

[Abstract] The coefficient of linear expansion can be changed by changing the concentration homogeneity of alloys. Microconcentration heterogeneity may result from liquation phenomena during crystallization or redistribution of alloying elements as a result of heat treatment. This work studies the influence of concentration microheterogeneities in N32 alloy created by heat treatment on the coefficient of linear expansion. The alloy contains 0.01% C and 32.5% Ni. The concentration heterogeneity was created in several stages of heat treatment including cooling in liquid nitrogen, α to γ conversion by heating to 400-520°C and rapid heating to 600°C. Resonant γ quantum absorption spectra are presented for the specimens following treatment. The change in coefficient of linear expansion at -100 to +150°C was found to correlate completely with changes in concentration homogeneity of the alloy. Figures 2; references 4: all Russian.

[82-6508]

RADIATION RESISTANCE OF CONDENSED NICKEL FILMS

Sverdlovsk FIZIKA METALLOV I METALLOVEDENIYE in Russian Vol 52, No 6, Dec 81
(manuscript received 20 May 80) pp 1225-1231

CHEREMSKOY, P. G., FUKS, M. Ya., TOLSTOLUTSKAYA, G. D., KHLISTUN, I. N.,
NECHITAYLO, A. A. and MARKUS, A. M., Khar'kov Polytechnical Institute
imeni V. I. Lenin

[Abstract] A study was made of the influence of helium ion bombardment at 1.6 meV energy, dose 10^{17}cm^{-2} and proton bombardment at 170 keV, dose 10^{15} to 10^{17}cm^{-2} , on the structure and properties of polycrystalline vacuum nickel condensates 10 and 2.5 μm thick as well as nickel foil 25 μm thick annealed in a vacuum at 1000°C. Helium ion bombardment did not heat the specimens to over 50% of the melting point, K. Proton bombardment was performed at room temperature. Processes of radiation pore formation occurred most intensively in non-crucible films condensed in an oil-free high vacuum. In low temperature non-crucible films bombarded with protons pore formation was accompanied by processes of recovery; higher temperature films bombarded with helium ions also underwent recrystallization, which did not occur when the specimens were heated to the same temperature but not bombarded. At a dose of 10^{15} protons/cm² processes of formation of small radiation pores predominated as the dose increased, submicropores formed in the initial stages primarily grew, accompanied by improvement in the structure of the condensate. The presence of an initial oriented porosity in combination with columnar structure of the condensate is a necessary condition for the creation of radiation-resistant coatings. Figures 4; references 13: 11 Russian, 2 Western.
[82-6508]

UDC: 669.245:669.018.45

HIGH TEMPERATURE OXIDATION OF Ni-Re ALLOYS

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 1, Jan-Feb 82
(manuscript received 15 Dec 80) pp 105-109

LAZAREV, E. M., KOROTKOV, N. A., ARSKAYA, Ye. P. and MILIYEVSKIY, R. A.,
Moscow

[Abstract] Analysis of studies of the kinetics of oxidation of alloys in the form of curves of increasing mass as a function of time shows that the processes of oxidation in most cases follow a near parabolic rule. Interrupted

oxidation of Ni-Re alloys was accompanied by partial flaking of the top layers of scale. The scale had two layers on all the alloys studied, one layer on unalloyed nickel. Addition of small quantities of rhenium has practically no influence on the rate of oxidation of nickel at 1000-1200°C, while a nickel alloy containing 25% Re is oxidized approximately half as fast as unalloyed nickel. The top layer of the scale consists of NiO and the bottom layer of a mixture of NiO and ReO₂, a result of the low diffusion permeability of nickel oxide for rhenium. Two-way diffusion occurs during oxidation of Ni-Re alloys: nickel out through the scale and oxygen into the alloy. Figures 5; references 10: 9 Russian, 1 Western.
[86-6508]

UDC: 669.245'26:669.018.45

INFLUENCE OF LANTHANUM, TITANIUM AND NIOBIUM ON SCALE RESISTANCE OF
CHROME-NICKEL ALLOY IN AIR, COMBUSTION PRODUCTS OF FUEL OIL

Moscow IZVESTIYA AKADEMII NAUK SSSR: METALLY in Russian No 1, Jan-Feb 82
(manuscript received 4 Nov 80) pp 110-114

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[Abstract] A study was made of the influence of lanthanum, titanium and niobium on the oxidation kinetics, composition and structure of oxide films formed on an alloy of 40% nickel and 60% chromium at 800-1100°C in air over a period of 100-1000 hours and in the combustion products of fuel oil containing about 3% sulfur at about 950°C in 500 hours. The oxidation curves of the alloys with lanthanum at all temperatures and with titanium or niobium at 800°C are logarithmic. Qualitative spectral analysis shows that an increase in the content of titanium or niobium in the alloy is accompanied by an increase in their concentration in the scale. When the quantity of titanium or niobium in the scale becomes sufficient to form oxides the scale ceases to be a single-phase scale and its protective properties decrease. The scale formed upon oxidation of low-alloy specimens in air consists of Cr₂O₃ and has good protective properties. The corrosion resistance of chrome-nickel alloys with high chromium content in the combustion products of oil is greater than that of commercial heat resistant alloys. The addition of small quantities of lanthanum and titanium increases corrosion resistance by 5 to 15%.
Figures 3; references 12: 5 Russian, 3 Western.
[86-6508]

INSTRUMENTAL NUCLEAR PHYSICAL METHOD OF DETERMINING CARBON IN THIN LAYERS

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[Abstract] A study is made of a new method of determining carbon in layers 3 to 10 μm thick using two nuclear reactions simultaneously: $^{12}\text{C}(\text{d},\text{p})^{13}\text{C}$ and $^{12}\text{C}(\text{d},\text{n})^{13}\text{N}$. The carbon content is determined by the difference between the total content of carbon (on the surface and in the volume) measured by the (d,n) reaction and the surface content, measured by the (d,p) reaction. The work was performed using a type EK-2 electrostatic generator at a deuteron energy of 1.0-1.7 MeV. The yields of the two reactions were measured by recording protons and annihilation γ quanta of the ^{13}N isotope. The sensitivity and accuracy of the method are determined by the accuracy of measurement and value of K, the coefficient of the relative contribution of superficial carbon to the total content. Since K is proportional to the surface content, one must attempt to decrease the sorption of carbon onto the surface of the analyzed specimen. For this purpose the surface was preliminarily heated by a beam of protons, which did not cause noticeable activation of the specimen. The kinetics of degassing of the surface were studied using a beam of deuterons in the reaction (d,p). The limit of detection with this method of degassing was $5 \cdot 10^{-5}$ mass %. The accuracy of the method is 10% (rel.). Figures 3; references 8: 4 Russian, 4 Western.
[84-6508]

NEW APPROACH TO STUDY AND PREDICTION OF THERMAL STABILITY OF POLYMERS
AT HIGH HEATING RATES

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[Abstract] A method of laser probing was developed to determine the thermal stability of polymers when rapidly heated and to validate an equation based upon prediction of thermal stability by establishing the interaction of thermal polymer decomposition processes with relaxation phenomena. The laser beam reflected from the surface was used to reveal the physical and chemical conversions occurring in the polymer. The heat was applied to the specimens by a stream of high temperature gas; the low-intensity laser beam was used only as a probe to sense physical and chemical changes occurring on the surface of the polymer. Specimens of polymethylmethacrylate and polyoxadiazol were studied in an inert atmosphere at a temperature rise rate of 0.67 to 5.33 K/s. The divergence of calculated and experimental data did not exceed 30°K.

Figures 3; references 14: all Russian.

[83-6508]

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